United States Department of Agriculture

Soil Conservation Service

Phoenix Arizona

FLOOD PLAIN MANAGEMENT STUDY

for the area of

FRYE CREEK - SPRING CANYON
TOWN OF THATCHER

Graham County, Arizona

MARKOW - Photography

prepared by the

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PHOENIX, ARIZONA

in cooperation with the

TOWN OF THATCHER
GRAHAM COUNTY
GILA VALLEY NATURAL RESOURCE CONSERVATION DISTRICT
ARIZONA DEPARTMENT OF WATER RESOURCES

JUNE 1986

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Department of
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FLOOD PLAIN MANAGEMENT STUDY

for the area of

FRYE CREEK-SPRING CANYON

TOWN OF THATCHER

Graham County, Arizona

INTRODUCTION

Study Request

The Town of Thatcher requested the assistance of the Soil Conservation Service, through the Gila Valley Natural Resource Conservation District, to perform this study. Although a flood insurance study (Reference 1) has been made of some of the area, additional information was needed to (1) include areas expected to be developed, (2) to provide more detailed flood hazard data, and (3) to evaluate alternatives for flood plain management to reduce hazard to life and property.

Local Input

Thatcher provided general guidance as the study progressed. Town personnel also provided building value and height from ground to first floor estimates for use in the damage analysis.

Authorities

A plan of work was developed, approved and signed by the sponsors in January 1984. Authorization to perform the study was granted February 9, 1984 by the Chief of the Soil Conservation Service.

The studies were performed under authorities set forth in Section 6, Public Law 83-506, Watershed Protection and Flood Prevention Act. Another authority is set forth in Executive Order 11988, Flood Plain Management, Section 1, with regulations continued in 7 CFR 650.25. The regulations instruct federal agencies regarding their responsibilities to avoid the risk of flood loss, minimize impacts and to restore and preserve the natural and beneficial values served by flood plains. A Unified National Program for Flood Plain Management, Water Resources Council, September 1979, provided for the acceleration of flood plain studies to assist state and local users.

Arizona Revised Statutes require communities to delineate and manage flood plains. These statutes give cities or towns the option of having their own flood plain management powers and duties, or relinquishing them to a flood control district.

Technical Procedures

Detailed hydraulic and hydrologic analyses were made of all flow paths within the study area. Procedures included developing data with field investigations and aerial mapping techniques. The data were used in the Corps of Engineers' HEC-2 computer program to calculate water surface profiles (Reference 3), and the SCS TR-20 Rainfall-Runoff Model (Reference 7), to compute a flood flow-frequency relationship.

Reliability

Despite the detailed intensity of the study, the nature of the channels and alluvial fan flood plain prevent results that can be considered to be highly accurate. Shallow flood flows can be greatly affected by barriers and obstructions such as local earthen mounds, streets, low berms, fences, debris deposition, etc. Such conditions make precise definition impossible, and require that caution be used in precise interpretation of mapping and flood depth at any specific point.

STUDY AREA DESCRIPTION

Location

The study area is located in southeastern Arizona, in the central part of Graham County. Safford, the county seat, is located three miles southeast. Refer to Figure 1. Much of the area is within the boundaries of the Town of Thatcher, although the golf course is owned by the City of Safford.

The area lies at the foot of the northeasterly slopes of Mount Graham and drains into the Gila River. The Gila River system is in the Lower Colorado Region. The watershed area is identified as Hydrologic Unit 15040005070.

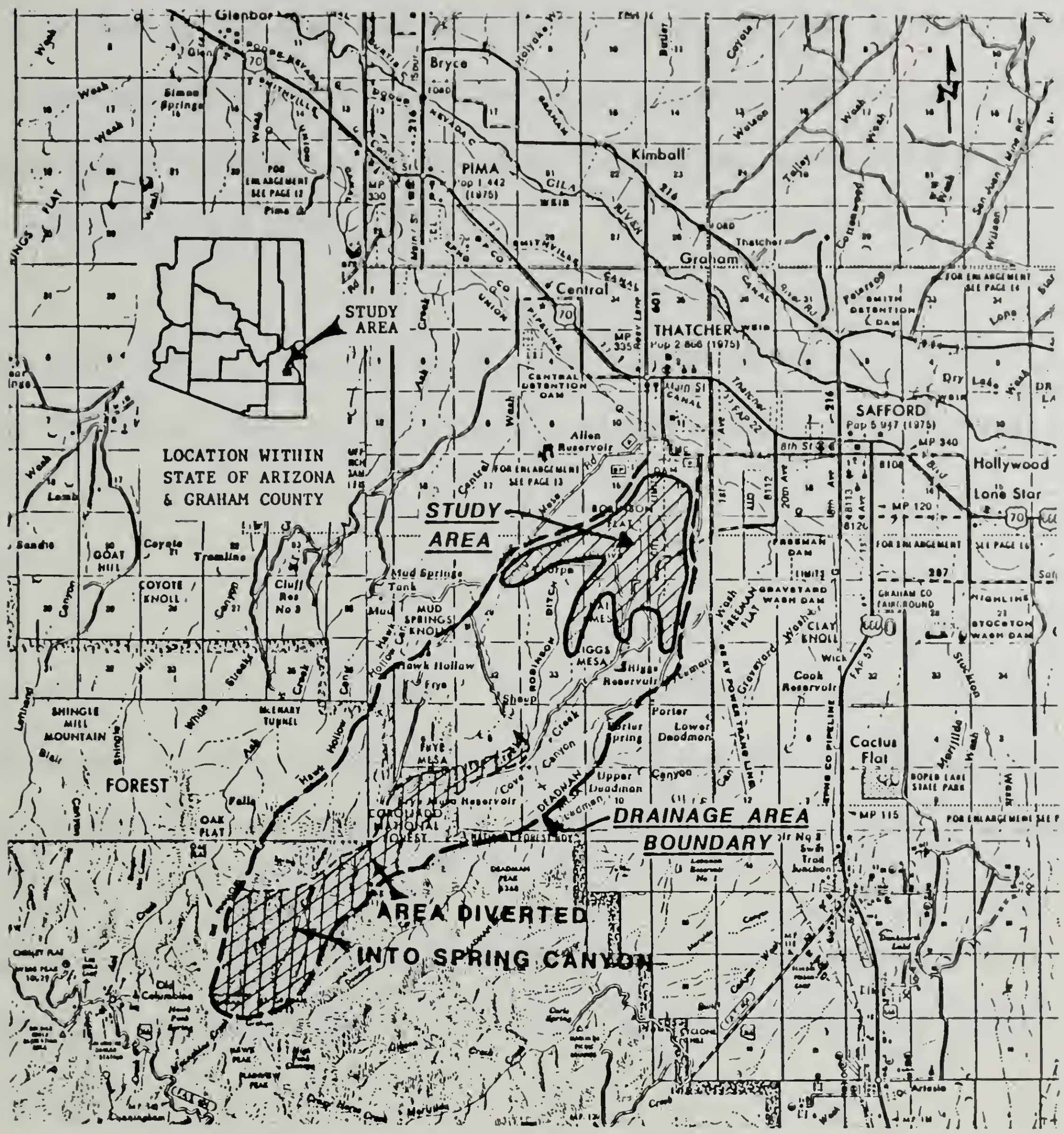


FIGURE 1: LOCATION MAP

Settlement History

Most of the study area was developed as an original part of the Robinson and Riggs ranches. The City of Safford purchased some of this property in the early 1930s and started developing the golf course about 1940. The major part of the golf course was constructed during the period 1946 to 1952.

Subdivision land in the area was homesteaded land that was sold for taxes. Ned Daley made the purchase in 1952 and began constructing houses in 1965. The residential developments, known as Daley Estates, were annexed into the Town of Thatcher in March 29, 1971.

The 1980 census shows a population of 1613 located in the area south of Church Street in Thatcher. Most of these people reside within the study area.

Climate

The residential area, Daley Estates, lies at the foot of Mount Graham, in the elevation range of 3040 to 3098 feet above mean sea level. The highest point in the watershed is Mount Graham Peak at 10,720 feet above mean sea level.

This major mountain, part of the Pinaleno Mountains, has marked effects on the local climate. The most important of these is the reduction in winter precipitation.

Most of southern Arizona has a primary precipitation maximum in the summer and a secondary maximum during the winter. The summer precipitaion is due largely to the thunderstorm rainfall during July, August and September, that is associated with warm, moist air moving northwestward over the state from the Gulf of Mexico. Winter precipitation, however, results from storms that enter the state from the Pacific Ocean via southern California. The moisture-bearing winds associated with these storms usually move over the state from the west or southwest quadrants. The Pinaleno Mountains form a massive

natural barrier which intercepts some of the moisture before it reaches the study area. A major part of this moisture falls as rain or snow on the windward side and along the summit of these mountains.

The diurnal temperature range (difference between the high and low temperature on a given day) is usually large, averaging 31 degrees Fahrenheit in the winter and reaching a maximum of about 37 degrees in May and June. Afternoon temperatures during the winter normally reach the sixties, but temperatures in the eighties have been experienced. Afternoon temperatures during the summer months are consistently in the high nineties to low hundreds with low relative humidity.

Below-freezing nighttime temperatures are rare from April through October. The growing season averages about 200 days (Reference 10).

Soil Resources

The major portion of the soils in the study area has been mapped as Anthony and Gila gravelly sandy loams, 0 to 2 percent slopes. This undifferentiated group of soils is on flood plains of streams and washes of the inner valley. The surface layer is mainly gravelly sandy loam but is sandy loam, in places. Drainageways are choked with sand and gravel, but the large washes are entrenched in the flood plain (Reference 6).

These soils are used for urban development, recreation, rangeland and wildlife habitat.

All the soils in the study area flood plain have moderate infiltration rates even when thoroughly wetted. If some plant cover is maintained, the hazard of wind or water erosion is slight.

Drainage Areas and Stream Lengths

The study area was divided into four subareas for analysis. These four areas with their drainage area size and length of streams studied in each are listed as follows:

Subarea	Drainage Area (mi^2)	Stream Length (Miles)
Frye Creek	3.00 1/	2.27
Frye Creek Tributary	2.43	1.12
Local Developed Areas	0.96	6.12
Spring Canyon & Tributaries	16.92 2/	5.30
TOTALS	23.31	14.81

1/ The area below the recently constructed diversion.
2/ Includes the area in Frye Creek above the recently constructed diversion. Refer to Fig. 1.

NATURAL FLOOD PLAIN VALUES

Upland Vegetative Cover/Land Use

Approximately 36 percent of the total watershed lies within the Coronado National Forest. The vegetation above the flood plain mapping area (study area), including the national forest area, is as follows (Reference 9):

Forest Woodlands Douglas fir, Engelmann spruce, white fir, aspen	22 percent
Pinyon-Juniper pinyon pine, juniper, oak, mountain mahogany	17 percent
Desert Shrub mesquite, white thorn, creosote bush, cactus, yucca, lycium, catclaw	61 percent

Land Uses in the 100-yr Flood Plain

The 100-yr flood is expected to inundate about 1020 acres within the study area. The uses of this land includes 10 percent in residential use; 6 percent for recreation (golf course); and 84 percent in rangeland.

There is no prime farmland within the study area.

Wildlife Resource Areas

Following is a description of the vegetation and land use within the study area as they relate to natural values, especially wildlife resources. Refer to Figure 2 and to the associated map in back of the report.

Creosote - catclaw - tarbush uplands

These areas lie between the major drainages. Some feed is available in the fall for quail. A few jackrabbits inhabit this resource area along with coyotes, fox, badger and probably bobcats.

Mesquite - catclaw - whitethorn - creosote benchland

These areas lie alongside and are intertwined within the major drainage channels. Vegetation benefits from extra subterranean water. The leguminous plants provide seed, leaves and nesting/cover components of habitat. Water is scarce in the resource area but is found sufficiently close for those species requiring daily water.

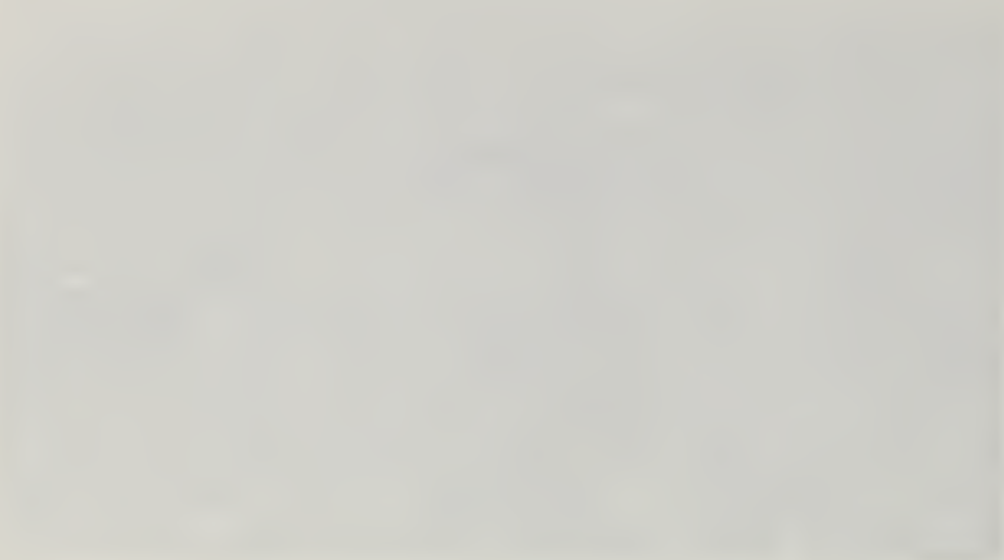
FIGURE 2: STUDY AREA
Looking north-northeast; Riggs Mesa left center; Daley Estates right center; Gila Valley through upper photo.

Mesquite - catclaw bottoms

This resource area lies right in the bottoms of the main and tributary arroyos. The vegetation is more luxuriant than that adjoining it, because of the additional moisture. It provides excellent food, cover and nesting areas for desert wildlife.

Fourwing saltbush - mesquite borrow areas

This area is where construction activities, early farming and other activities have taken place. Fourwing saltbush has moved onto the site along with annual weeds and grasses. Mesquite and occasional saltcedar are in the flood pool area of the Frye Creek floodwater retarding structure. These plants provide a good seed source for quail and doves. Cottontail rabbits, skunks and ground squirrels are frequently found in this resource area.



Seeps and artesian wells

These resource areas occur along old water conveyance systems, below reservoirs, around springs, artesian wells and old tanks. Saltcedar is the primary plant but there can also be cattail, bullrush, Johnsongrass, bermudagrass, cottonwood, mesquite, box elder, bata mote and desert broom. These resource areas are the most important "water-holes" for wildlife within the study area. Without these areas, there would be far fewer mammals, quail and perching birds.

Golf course

This area provides about everything needed for most indigenous life forms. It has a major impact on wildlife.

Residential areas

This area provides some trees for cover and nesting, some water and a little seed for food. Exotic trees are probably the most important part of the habitat in this area for exotic species including English sparrows, starlings and pigeons.

Historic and prehistoric sites

Cultural resources are plentiful. Homesteads and other historic sites (1888-1911) as well as some large prehistoric sites are found within this area.

FLOOD PROBLEMS

Flood History

Flooding from Frye Creek and Spring Canyon has caused problems for many years. These problems prompted the town to apply to the Soil Conservation Service for assistance under the authorities of the Watershed Protection and Flood Prevention Act (PL-566). The application was approved, and subsequently, a floodwater retarding structure and associated outlet channel were constructed (Reference 9). These measures have protected the Town of Thatcher since 1962.

With the development of land above the floodwater retarding structure in 1965, damage has again been experienced from Frye Creek and its tributary.

FIGURE 3: FRYE CREEK, OCTOBER 1983 FLOOD

Looking southwest from a point near the north end of Sage Trail Street.

Some runoff is expected every year, but since the construction of the Frye Creek floodwater retarding structure the most severe floods include the following (listed chronologically):

July	1965	October	1972
September	1967	December	1978
July	1968	October	1983
August	1972		

FIGURE 4: FRY CREEK, OCTOBER 1983 FLOOD
Looking north-northeast from a point on Frye Creek Road.

Area Inundated by the 100-Year Flood

It is estimated that within the study area the 100-year flood will cover the following area (acres):

Stream/Area	Flooded Area by Land Use (acres)			
	Residential	Golf Course	Rangeland	Total
Spring Canyon & Trib.	--	20	440	460
Frye Creek	22	41	134	197
Frye Creek Trib.	5	--	49	54
Frye Creek Trib. overflow & Local	74	--	235	309
	101	61	858	1020

Properties Affected and Estimated Damage

The 100-year flood is expected to affect the following properties:

Stream/Area	Number of Properties flooded by Type			
	Yards	Houses or Apartments	Storage Buildings	Mobile Homes
Frye Creek	33	--	14	22
Frye Creek Trib.	7	--	3	2
Frye Creek Trib. overflow & Local	94	36	15	4
TOTALS	134	36	32	28

The 100-year flood damage will amount to between $190,000 and $232,000. The average annual damage is expected to range from $17,400 to $21,300.

EXISTING FLOOD PLAIN MANAGEMENT

State and Local Regulations

Arizona Revised Statutes (ARS) require communities to delineate and manage flood plains. The statutes that especially address these requirements are ARS 45-2341 through 45-2909.

The Town of Thatcher has established Ordinance No. 51, entitled "An Ordinance Relating Flood Damage Prevention, Statutory Authorization, Findings of Fact, Purpose and Objectives". Its purpose is to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions. Under this ordinance, a development permit is required before any construction or development begins within any area of special flood hazard.

The definition of special flood hazard is that identified by the Federal Insurance Administration. Each permit is reviewed for conformance to the ordinance.

Special Study

In 1978 the Thatcher Town Council and Mr. Ned Daley contracted with Floyd F. LeFever, P.E. to make an indepth study of flood conditions within the Daley subdivision units. This study was intended (a) to provide guidelines for converting the area to the regular program of flood insurance, and (b) to outline suggested remedial measures to reduce flood hazards in the area (Reference 2). The study was not accepted by the Town Council or Mr. Daley because of contractual disagreements.

Structural Efforts

Past efforts have been made by land developers to control the flood waters within the study area. This work has mainly been channel construction within the Daley Estates subdivisions. Provisions have been made, to an extent, to convey the Frye Creek and the Frye Creek Tributary floodwaters through the developed areas. Minor work has been performed on Frye Creek Tributary immediately above the subdivisions. This work has been to straighten and enlarge the channel with a resulting capacity that can be expected to be exceeded, on the average, once in five years. Hoopes Avenue has been constructed to convey flood flows. All the construction has been done with little regard to achieving a planned degree of protection.

A concrete drop structure has been installed in Frye Creek on the golf course downstream from the golf course buildings. The drop (approximately 8 feet) was installed to stop the headcutting of Frye Creek channel on the golf course.

Recently an earthen diversion channel was constructed upstream about 3 3/4 miles (NW 1/4 SW 1/4 Sec. 4,T8S, R25E) to divert flows from Frye Creek into Spring Canyon. Refer to Fig. 1. This is expected to divert the 100-year flood peak at this point. The community is anxious to provide further protection to the developments.

Public Participation

A meeting was held on August 11, 1983 to discuss the proposed flood plain management study. Those attending the meeting included representatives from Thatcher, Safford, Graham County, Arizona Department of Water Resources and the Soil Conservation Service.

Items covered included an explanation of the purpose for a flood plain management study and its expected application. The scope of the study area was determined and areas of responsibility were defined. Some discussion was also directed toward flood plain management alternatives.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

Present Condition

Development within the study area is expected to continue even with the hazards of flooding. Streets have been constructed in the southern part of Daley Estates and more houses will undoubtedly be built. The Thatcher School District has property on the east side of the subdivision. The property is bounded on the west by Hoopes Avenue and on the north by Golf Course Road. Therefore, the potential exists for school buildings to be constructed in this location.

Without taking steps to protect these areas, either by structural or non structural methods, flood damage will persist and will increase with more construction.

Land Treatment

Frye Creek Watershed, above Frye Mesa Reservoir, is in relatively good condition. This has resulted from not allowing any grazing for several years. Below Frye Mesa Reservoir there is controlled summer grazing on national forest lands. Vegetative types restrict grazing to a great degree, and expected changes of this vegetation, especially in density, are very limited. Current benefit-cost relationship of land treatment practices in these areas of intermediate elevation are not favorable to produce changes needed to reduce the runoff-erosion process.

Good grazing systems are needed on the lower lying lands. Brush control, reseeding, deferred grazing and proper rotation grazing are practices that are needed and can be applied. Again, the application of treatment practices that may produce significant changes in runoff and erosion are not expected to occur because of the benefit-cost relationship.

Preservation and/or Restoration of Natural Values

Since none of the study area is prime farmland there is an advantage in using the area for residential and recreational purposes.

There is an obvious need for preservation of the natural environmental resources simply because climatic conditions greatly limit the amount of vegetation that will support wildlife. Therefore, the existing habitat should be carefully preserved to at least maintain the wildlife resources.

Further plans for development for any purpose, including flood protection measures, should carefully consider the habitat and the prehistoric and historic sites to minimize any adverse impact. Steps should be taken by the community to be aware and make others aware of these resources to promote their preservation.

Nonstructural Measures

The most effective nonstructural measure that can be implemented is to make all users of the land within an area aware of the flood hazards. To accomplish this, the first need is adequate flood data. The prime objective of this study report is to satisfy this need. Once the information has been prepared it must be made available to the public; especially, anyone proposing development in the flood plain areas.

Prohibiting building in the defined flood plain will prevent damages in the areas that are not currently developed. This would include the areas east of the Daley Estates that are affected by overflow from Frye Creek Tributary and Spring Canyon and its tributary areas. Enforcement of current regulations in town ordinances and the development permit requirements in particular, will achieve a high degree of protection. The ordinances should be strengthened by requiring that potential buyers be notified if property is in an area subject to flooding.

Flood proofing may be performed to protect individual properties. This could include constructing water-tight walls, sealing openings, providing for water barriers in doorways, etc. Flood proofing must be tailored to fit each structure. Since flooding throughout most of the area is shallow, flood proofing would need to extend up to only one or two feet in height.

Flood warning systems are not a practical solution. There is insufficient time between imminent flooding and arrival of the flood for the community to react.

Structural Measures

This study examined three structural systems that would reduce flooding to an acceptable level. These alternatives are described as follows. First, a floodwater diversion planned to intercept Frye Creek Tributary and divert the floodwater east past the Daley Estates to the natural swale (called School District Wash in the report) located east of and parallel to the subdivision. A grassed waterway, with sufficient drop structures to prevent erosion, would convey the floodwater to the existing Frye Creek floodwater retarding structure. Refer to Figure 5. The system is too costly compared with the benefits.

The second system included a floodwater diversion channel to intercept Frye Creek Tributary, then convey the water west and intercept Frye Creek. It would continue west to a location aligning with the west edge of the golf course. From this point, a grassed waterway with appropriate drops to prevent erosion would convey the water northward past the golf course into Spring Canyon and subsequently, into the existing Frye Creek floodwater retarding structure. Refer to Figure 6. The cost of this system also appears to exceed the expected benefits.

A third approach, briefly examined, is one proposed a few years ago. This involved a short diversion channel to divert Frye Creek Tributary out of the present watershed into the Freeman Wash watershed. An abbreviated examination of this alternative was made in 1982. The conclusions were this alternative would enlarge the Freeman Wash drainage area by 50 percent, would require raising the existing Freeman Wash floodwater retarding structure by five (5) feet, raise the crest of the emergency spillway by six (6) feet and require widening the

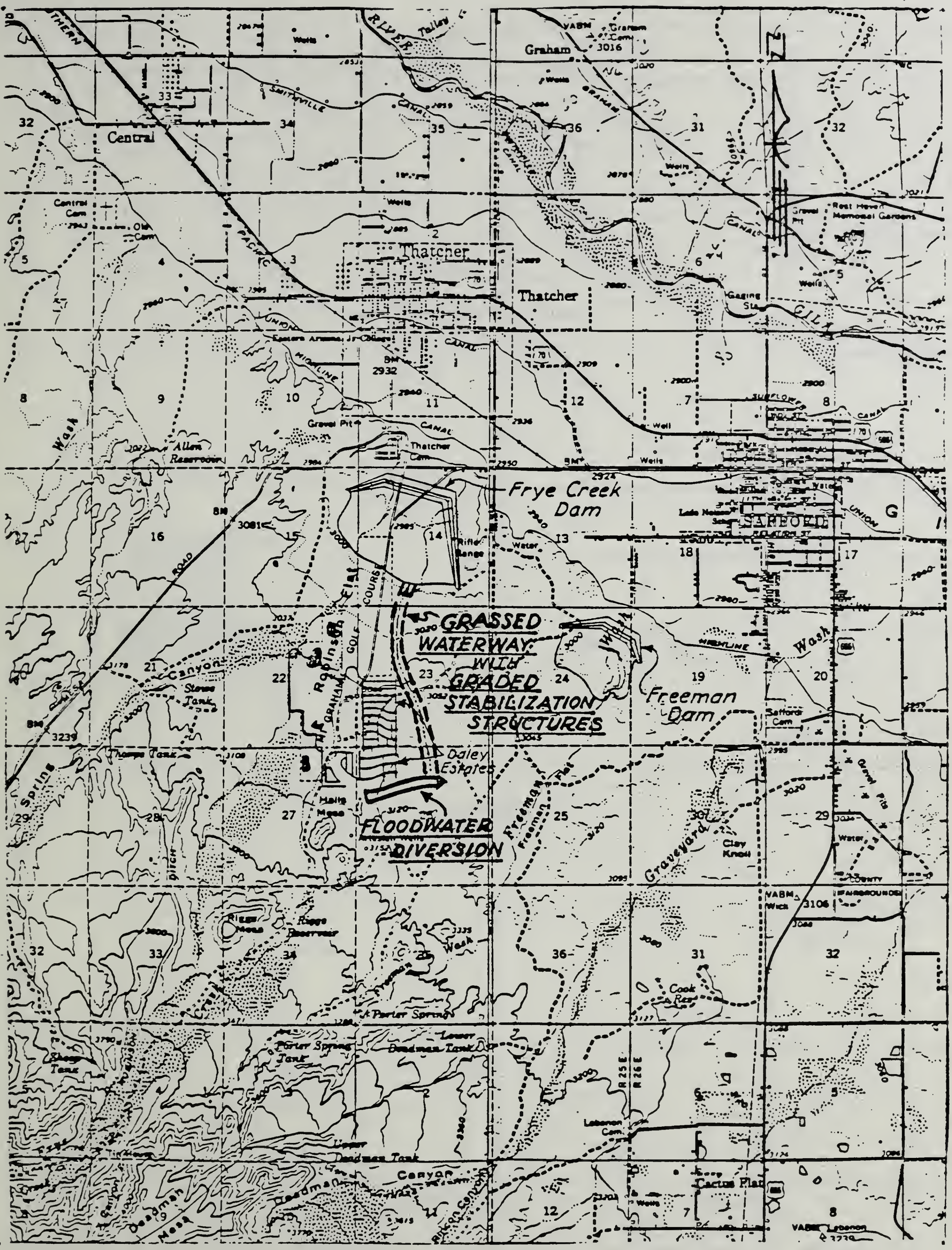


Fig. 5
Structural Alternative: Floodwater Diversion (to East) and
Grassed Waterway with Grade Stabilization Structures

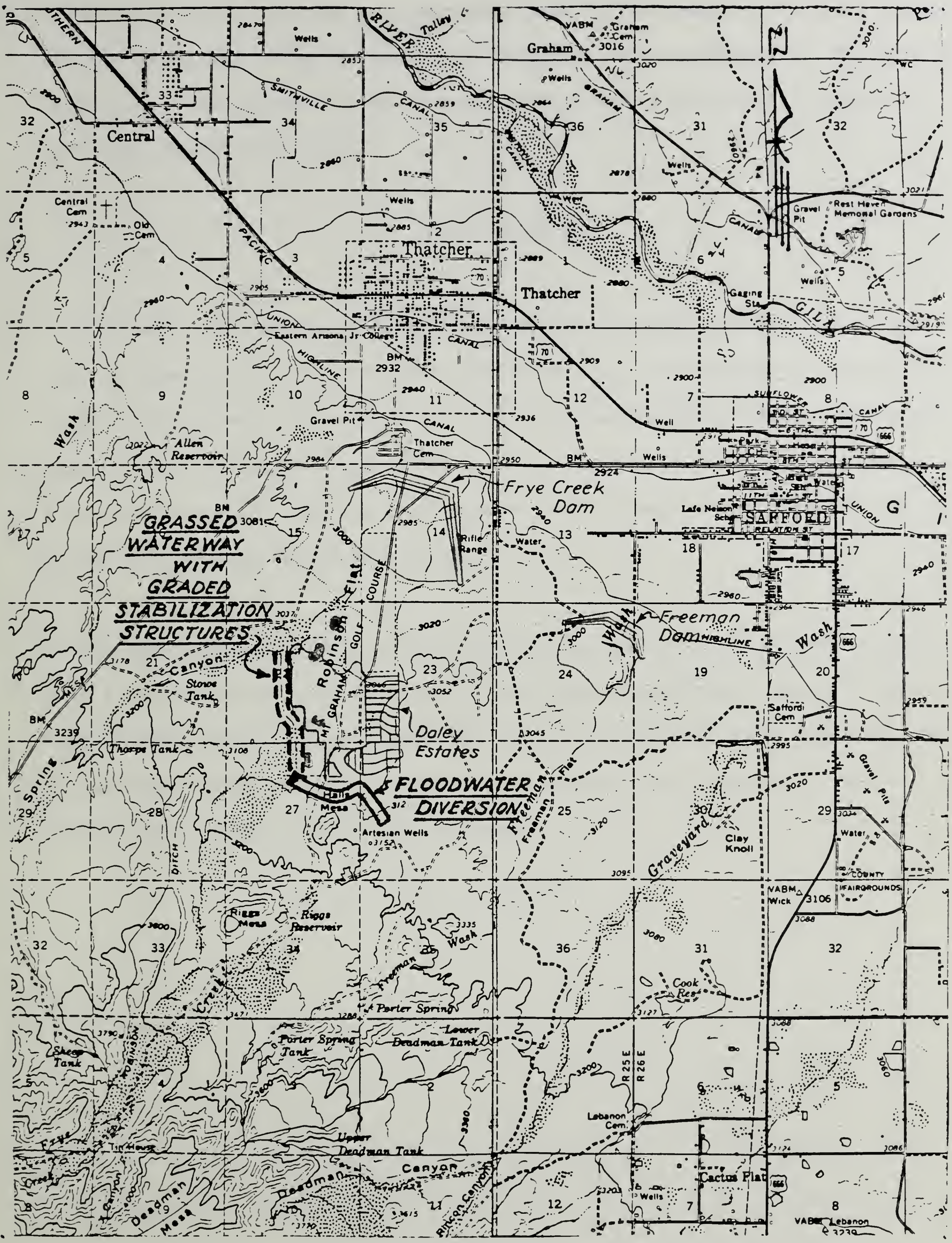


Fig. 6
Structural Alternative: Floodwater Diversion (to West) and Grassed Waterway with Grade Stabilization Structures

spillway. In addition, the existing paved road in the emergency spillway control section would have to be removed, then replaced. Refer to Figure 7. The cost of performing these alterations along with the diversion facilities is considered to exceed the benefits derived.

FLOOD HAZARD MAP

A Flood Hazard Map may be found in the packet at the back of this report. The map, on a photo base, shows the 100-year flood area, the location of many of the cross sections used, the elevations of the 100-year flood at ten foot intervals and the area of shallow flooding where the average depth is one foot or less. The areas of shallow flooding include Frye Creek through the golf course and all of the Daley Estate subdivision units.

To complement this map refer to the Technical Appendix. The appendix includes peak flow estimates, flood profiles for all areas except those designated as shallow flood areas, and representative cross sections with 500-, 100-, 50- and 10-year flood water surface elevations. Photos are also included to show the 100-year flood depth at selected locations.

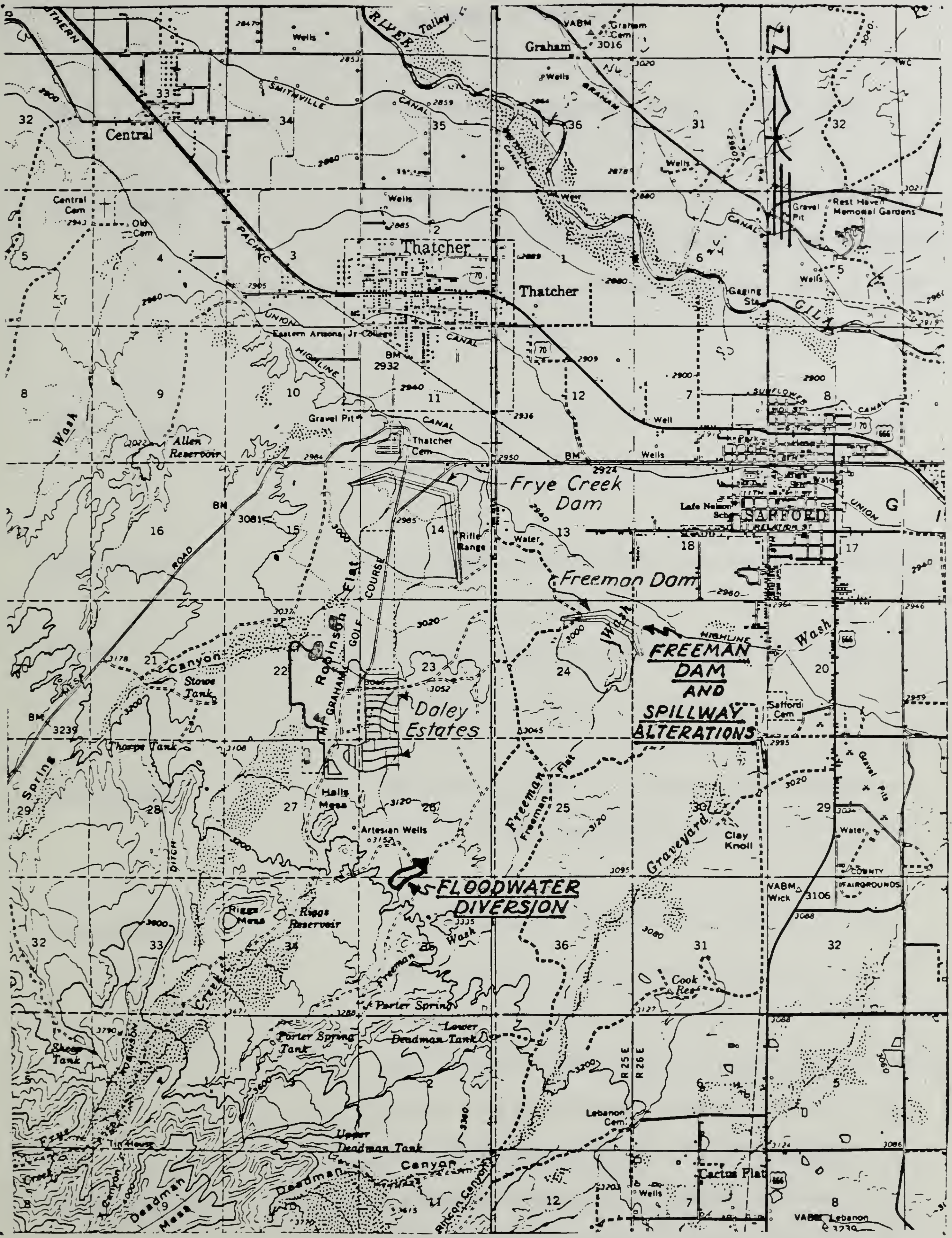


Fig. 7

Structural Alternative: Floodwater Diversion into Freeman Wash Watershed and Modification of Freeman Floodwater Retarding Structure

GLOSSARY OF TERMS

cfs	cubic feet per second. A unit of water flow.
cross section	A profile of the land surface taken at right angles to the direction of flow; made by measuring the elevation and distance at ground points along the selected line.
drainage area	The area draining into a stream at a given point (also watershed, drainage, catchment basin).
drainageway	A conveyance structure to remove water (channel).
flood	An event where a stream overflows its normal banks.
flood plain	The land adjacent to a body of water which has been or may be hereafter covered by flood water.
flood frequency	An expression or measure of how often a flood event of a given size or magnitude should on the average, be equaled or exceeded. For example a 100-year frequency flood should be equaled or exceeded in size, on the average, only once in 100 years (also recurrence interval, return period).
flood profile	A graph or a longitudinal profile showing the relationship of the water-surface elevation of a flood event to location along a stream or river.

flood proofing	A combination of structural provisions, changes, or adjustments to properties and structures subject to flooding primarily for the reduction or elimination of flood damages to properties, water and sanitary facilities, structures, and contents of buildings in a flood-hazard area.
flood warning	A community or locally based system consisting of volunteers; rainfall, river and other hydrologic gages; hydrologic models or procedures; a communication network; and a community or local flood coordinator responsible for issuing advance information relative to potential flooding.
indigenous life	Life having originated in and being produced, growing or living naturally in a particular region or environment.
hydraulics	The science that treats water in motion.
hydrology	The science that deals with the occurrence and behavior of water in the atmosphere, on the ground and underground.
M^2	Square miles; a unit of area.
NGVD	National Geodetic Vertical Datum; sea-level datum of 1929, based on leveling surveys of the U.S. Coast and Geodetic Survey.

overland flow — Runoff which flows over the ground surface in a shallow layer as opposed to channelized flow.

peak discharge — The maximum discharge or rate of flow during a flood at a given location.

peak flood elevation — The highest stage or elevation reached by a flood at a given location.

riparian vegetation — The vegetated area and biotic communiity influenced by high water tables adjacent to streams and surface waters.

routing — Determining the changes in a flood wave as it moves downstream through a flood plain or reservoir.

runoff — That portion of precipitation which contributes to flow in a channel or across the land surface (excess rainfall).

REFERENCES

1. Federal Emergency Management Agency; Flood Insurance Study, Town of Thatcher, Arizona, Graham County; June 15, 1983.

2. Floyd F. LeFever, P. E.; Flood Hazard Study of Daley Estates of Thatcher, Arizona; November 1980.

3. Hydrologic Engineering Center, US Army Corps of Engineers; HEC-2 Water Surface Profiles Computer Program; Users Manual, September 1982.

4. National Weather Service, NOAA, USDA; NOAA Atlas No. 2, Precipitation-Frequency Atlas of Western United States, Volume VIII, Arizona; 1973.

5. Soil Conservation Service, USDA; SCS National Engineering Handbook Section 4 - Hydrology; 1972.

6. Soil Conservation Service, USDA; Soil Survey Safford Area, Arizona; June 1970.

7. Soil Conservation Service, USDA; Technical Release No. 20, Computer Program for Project Formulation Hydrology; May 1983 (Draft Revision)

8. Soil Conservation Service, USDA; Urban Floodwater Damage Economic Evaluation (URB1) Computer Application Program; January 1982 (Draft).

9. Soil Conservation Service, USDA; Watershed Work Plan Frye Creek-Stockton Wash Watershed, Graham County, Arizona; September 1958.

10. University of Arizona, Tucson; Arizona Climate, 1931-1972; Editors, William D. Sellers and Richard H. Hill; Revised 2nd Edition, Copyright 1974.

ELEVATION REFERENCE MARKS

December 7, 1984

ELEVATION REFERENCE MARK	DESCRIPTION
1	1/2" Rebar in the center of an old road in a newly brushed area adjacent to a power pole. Elevation 3001.81
2	1/2" Rebar in the center of a flood control dam adjacent to a microwave dish. Elevation 2999.25
3	1/2 " Rebar 100'± East of Frye Mesa Road. Elevation 3110.92
4	1/2" Rebar 50'± West of an old road scar, West of bee hives. Elevation 3016.66
5	1/2" Rebar 150'± East of Frye Mesa Road, 800'± South of intersection of said road with a road to the East. Elevation 3189.32
6	1/2" Rebar some 600' Northeast of the above East and West road where said road intersects with Spring Canyon Arroyo. The point is in a small clearing on the West bank of the arroyo. Elevation 3123.53
7	1/2" Rebar is at the North edge and angle point of an elevated golf course service road where the road turns from East and West to North and South. Elevation 3063.71
8	1/2" Rebar 15'± inside the South highway right-of-way fence adjacent to the terminus of a North and South fence with said South row fence. Elevation 3046.61
9	1/2" Rebar on the side of a mesa just behind and West of a small hummock in what appears to be an old fenceline scar. Elevation 3164.98
10	1/2" Rebar in a small clearing at the foot of a mesa 50'± West of the Frye Canyon Arroyo. Elevation 3347.25
11	1/2" Rebar in a cleared and leveled area adjacent to the pumping station for Riggs Reservoir. Elevation 3231.75
12	1/2" Rebar 50'± West of a trail road that runs Northeast and Southwest some 600'± South of a road intersection. Elevation 3168.47

Base of Elevation:

City of Safford, BM 1 as noted for a previous study. BM 1 is defined as a "concrete monument by power pole of fence line near corrals at Southwest corner of mobile home unit. By City of Safford Engineering Department. Elevation given 3091.04".

TECHNICAL APPENDIX

INVESTIGATIONS AND ANALYSES

Hydraulic and hydrologic studies were performed to derive water surface elevation-frequency estimates. This was used for plotting on cross sections and, subsequently, for mapping flood boundaries. The data also were used to estimate flood depths and resulting damages. Field inventories were made to assess natural flood plain values.

Hydraulic Studies

The basic field survey data were acquired by aerial mapping techniques. This work, completed in 1985, provided topographic maps, scale 1" = 200' (1:2400), contour interval of 2 feet; cross section data and plottings; and profile data and plottings.

Roughness coefficients were estimated and mapped in the field. Also the paths of low flow in the developed areas, along with ill-defined channel systems, were examined and identified as best possible.

Hydraulic computations were made using the US Army Corps of Engineers computer program HEC-2 Water Surface Profiles (Reference 3). This study provided the basic rating relationship (elevation-discharge) for each cross section.

Hydrologic Studies

There are no continuous streamflow data available for the streams in the study area. There are miscellaneous measurements of some individual flood events. There have also been previous studies made by the Soil Conservation Service, 1958 (Reference 9); Floyd F. LeFever, P.E., 1980 (Reference 2) and the Federal Emergency Management Agency, 1983 (Reference 1).

The Soil Conservation Service rainfall runoff simulation model, TR-20 (Reference 7) was used to estimate peak flow-frequency relations for current conditions and for alternative flood plain management schemes. The following input data and source were developed to use with this computer program:

Input Data	Source
Drainage areas	USGS 7.5 minute quadrangle sheets and the 1:2400 topographic maps developed for this study.
Hydrologic soil-cover complexes (Curve Numbers)	Soils taken from the SCS published soil survey (Reference 6) Vegetative cover taken from the inventory of natural flood plain values made as part of this study and from the hydrology studies relative to the Watershed Work Plan, Frye Creek-Stockton Wash (Reference 9). SCS National Handbook Sec. 4 (Reference 5).

Times of concentration	Estimated from profiles taken from 7.5 minute quadrangle maps and approximate hydraulic parameters of channel cross sections.
Precipitation	NOAA Atlas No. 2, Volume VIII - Arizona. (Reference 4)
Channel flood routing	Taken from HEC-2 output ratings of elevation-discharge-area for selected cross sections.
Storm distribution	A 24 hour storm distribution developed by SCS in New Mexico with 75 percent of the rainfall in one hour. Considered to best define short duration intensities experienced in this location.

The results of the peak flow estimates for selected frequencies and locations are shown in Table 1. These estimates are for conditions with the current diversion of Frye Creek into Spring Canyon. The diversion was constructed in 1984.

The material described below is presented on fold-out sheets immediately following Table 1.

Flood profiles for the better defined streams. Profiles are for the 500-, 100-, 50-, and 10-year floods. Representative cross sections with corresponding flood frequencies, plotted to show expected depths of flooding. Photos showing flood depths at selected locations to complement the cross sections and show expected flood depths for the 100-year flood.

Damage Studies

Damage analyses were performed to assess the need and opportunity to take action in reducing the hazards of flooding. Output from the hydraulic and hydrologic studies were used in the URB1 computer program (Reference 8) to perform this work.

The Town of Thatcher provided inventory data of building values and height from ground level to first floor elevation for each building. Ground elevation of each building was determined with aerial mapping using photogrammetric techniques.

General damage coefficients were taken from data provided by Soil Conservation Service and Corps of Engineer sources. Site-specific data for the study area, normally developed from damage interviews, were not developed for this study.

Inventory of Natural Flood Plain Values

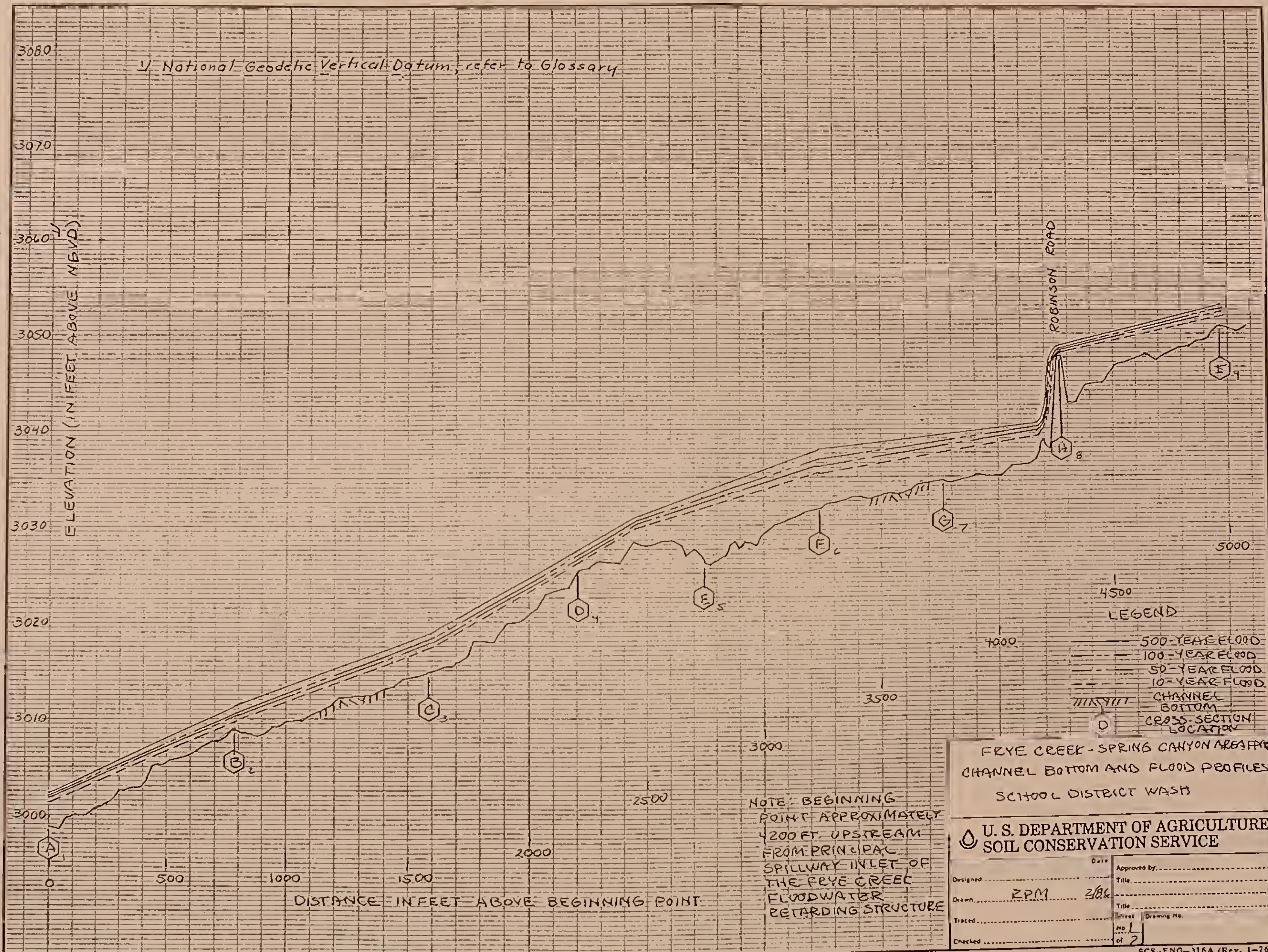
Mapping units were used as a basis to make field inventories of wildlife resources. A data search was made to inventory and describe historic and prehistoric resources. Refer to the report and the map at the back.

Following is a tabulation presenting the estimates of peak flows for selected average return periods and locations. These estimates are for current conditions that represent the Frye Creek diversion into Spring Canyon. The diversion was constructed in 1984.

Table 1 - Peak Discharge Estimates

Flooding Source and location	Drainage Area (mi^2)	Peak Discharge (cfs) 10-year	50-year	100-year	500-year
Frye Creek					
at diversion	5.02	2040	4020	5060	7660
at Frye Creek Rd. above Trib. confluence	2.42 *	1200	1890	2210	3230
at golf course below Trib. confluence	4.52 *	1960	2700	3090	4140
Frye Creek Tributary					
S. alignment w/Hoopes Ave.	2.19	1580	2950	3650	5370
above confluence with Frye Creek	2.10 *	970	1080	1110	1200
School District Wash					
at Golf Course Rd.	0.43	320	480	600	850
Fairway Avenue					
at Brinkerhoff St.	0.25 *	570	1300	1640	2490
Hoopes Avenue					
at Brinkerhoff St.	0.21 *	70	670	910	1470
Spring Canyon					
above confl. w/Frye Cr.	16.77	4530	7960	11,500	17,700
below confl. w/Frye Cr.	22.45	6020	10,220	14,800	22,770
Spring Canyon Trib.					
above golf course	1.90	780	1420	2090	3,290

* These flows are affected by upstream overflows either into or out of the water course.



1/ National Geodetic Vertical Datum; refer to Glossary
ELEVATION (IN FEET ABOVE NGVD) 1/
3080
3070
3060
3050
3040
3030
3020
3010
3000
DISTANCE IN FEET ABOVE BEGINNING POINT
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
ROBINSON ROAD
A 1
B 2
C 3
D 4
E 5
F 6
G 7
H 8
I 9
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
NOTE: BEGINNING POINT APPROXIMATELY 4200 FT. UPSTREAM FROM PRINCIPAL SPILLWAY INLET OF THE FRYE CREEK FLOODWATER RETARDING STRUCTURE
FRYE CREEK - SPRING CANYON AREA FPP
CHANNEL BOTTOM AND FLOOD PROFILES
SCHOOL DISTRICT WASH
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed
Drawn RPM 2/86
Traced
Checked
Date
Approved by
Title
Sheet No. 1 of 2
Drawing No.
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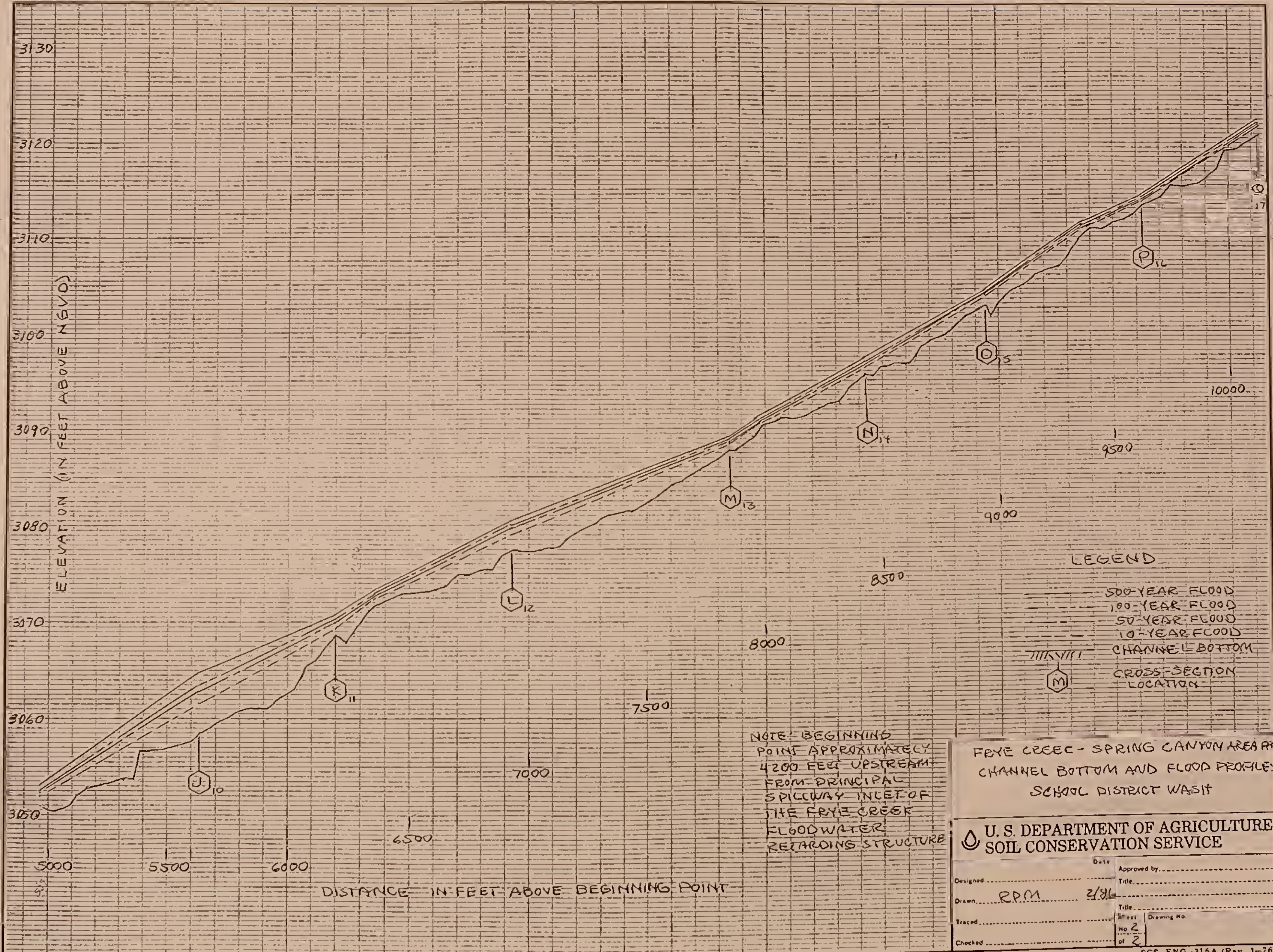
3130
3120
3110
3100
3090
3080
3070
3060
3050
ELEVATION (IN FEET ABOVE NGVD)
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
10000
DISTANCE IN FEET ABOVE BEGINNING POINT
J 10
K 11
L 12
M 13
N 14
O 15
P 16
Q 17
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
NOTE: BEGINNING POINT APPROXIMATELY 4200 FEET UPSTREAM FROM PRINCIPAL SPILLWAY INLET OF THE FRYE CREEK FLOODWATER RETARDING STRUCTURE
FRYE CREEK - SPRING CANYON AREA FHS
CHANNEL BOTTOM AND FLOOD PROFILES
SCHOOL DISTRICT WASH
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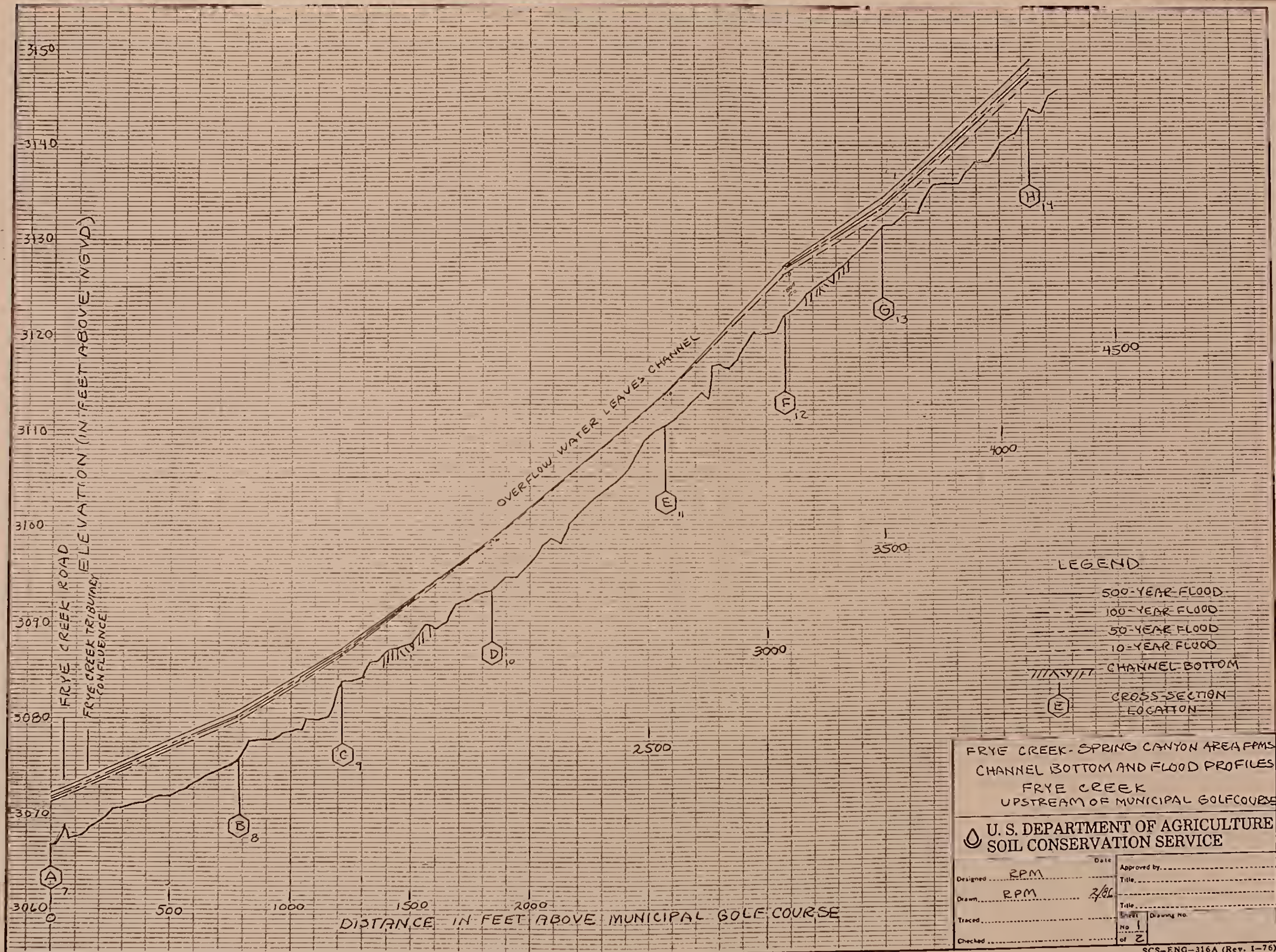
3150
3140
3130
3120
3110
3100
3090
3080
3070
3060
ELEVATION (IN FEET ABOVE NGVD)
FRYE CREEK ROAD
FRYE CREEK TRIBUTARY CONFLUENCE
OVERFLOW WATER LEAVES CHANNEL
0
500
1000
1500
2000
2500
3000
3500
4000
4500
DISTANCE IN FEET ABOVE MUNICIPAL GOLF COURSE
A 7
B 8
C 9
D 10
E 11
F 12
G 13
H 14
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
FRYE CREEK - SPRING CANYON AREA FPMS
CHANNEL BOTTOM AND FLOOD PROFILES
FRYE CREEK
UPSTREAM OF MUNICIPAL GOLFCOURSE
U. S. DEPARTMENT OF AGRICULTURE
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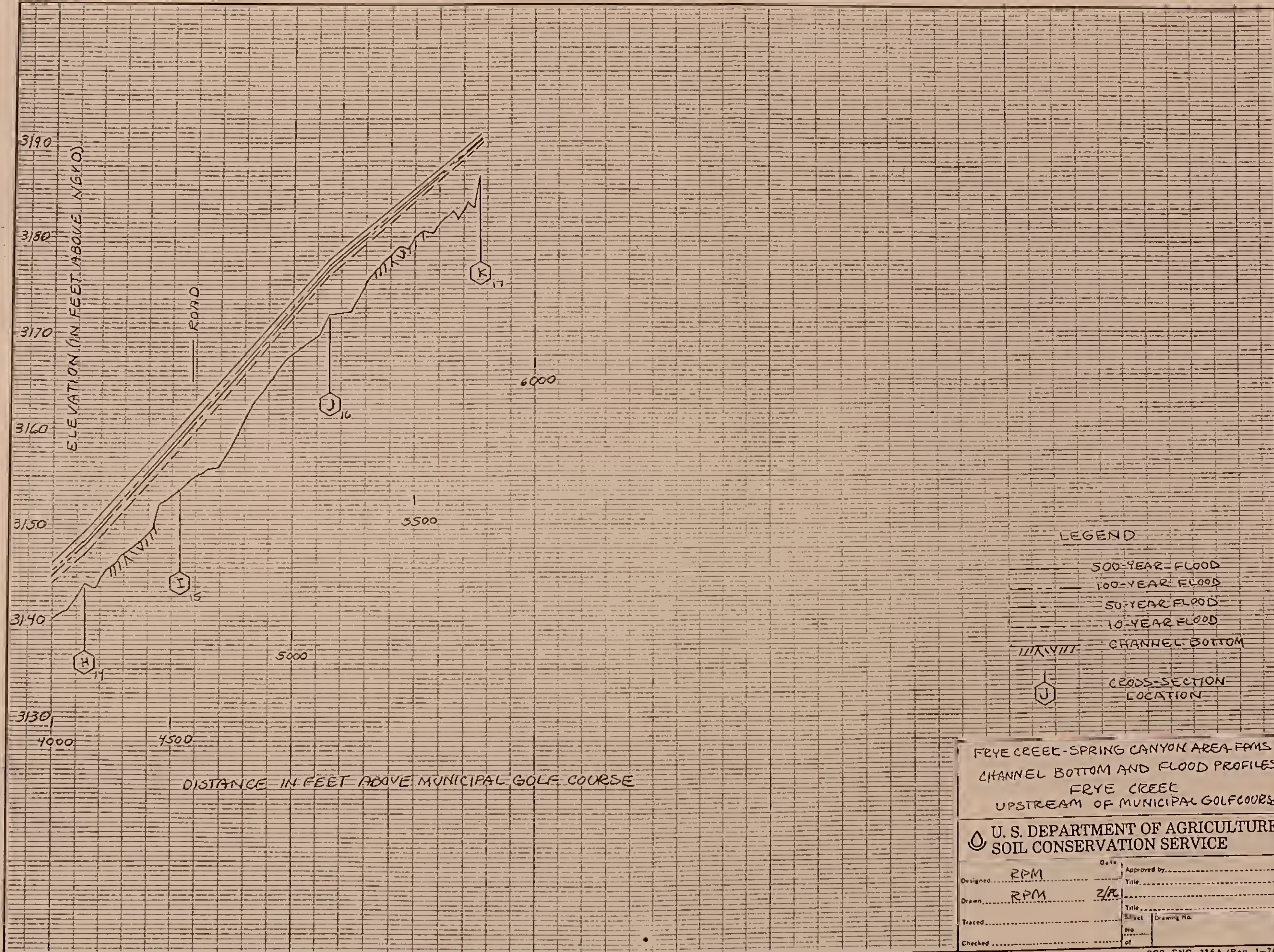
ELEVATION (IN FEET ABOVE NGVD)
3190
3180
3170
3160
3150
3140
3130
ROAD
K 17
J 16
I 15
H 14
4000
4500
5000
5500
6000
DISTANCE IN FEET ABOVE MUNICIPAL GOLF COURSE
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
FRYE CREEK-SPRING CANYON AREA FPMS
CHANNEL BOTTOM AND FLOOD PROFILES
FRYE CREEK
UPSTREAM OF MUNICIPAL GOLFCOURSE
U. S. DEPARTMENT OF AGRICULTURE
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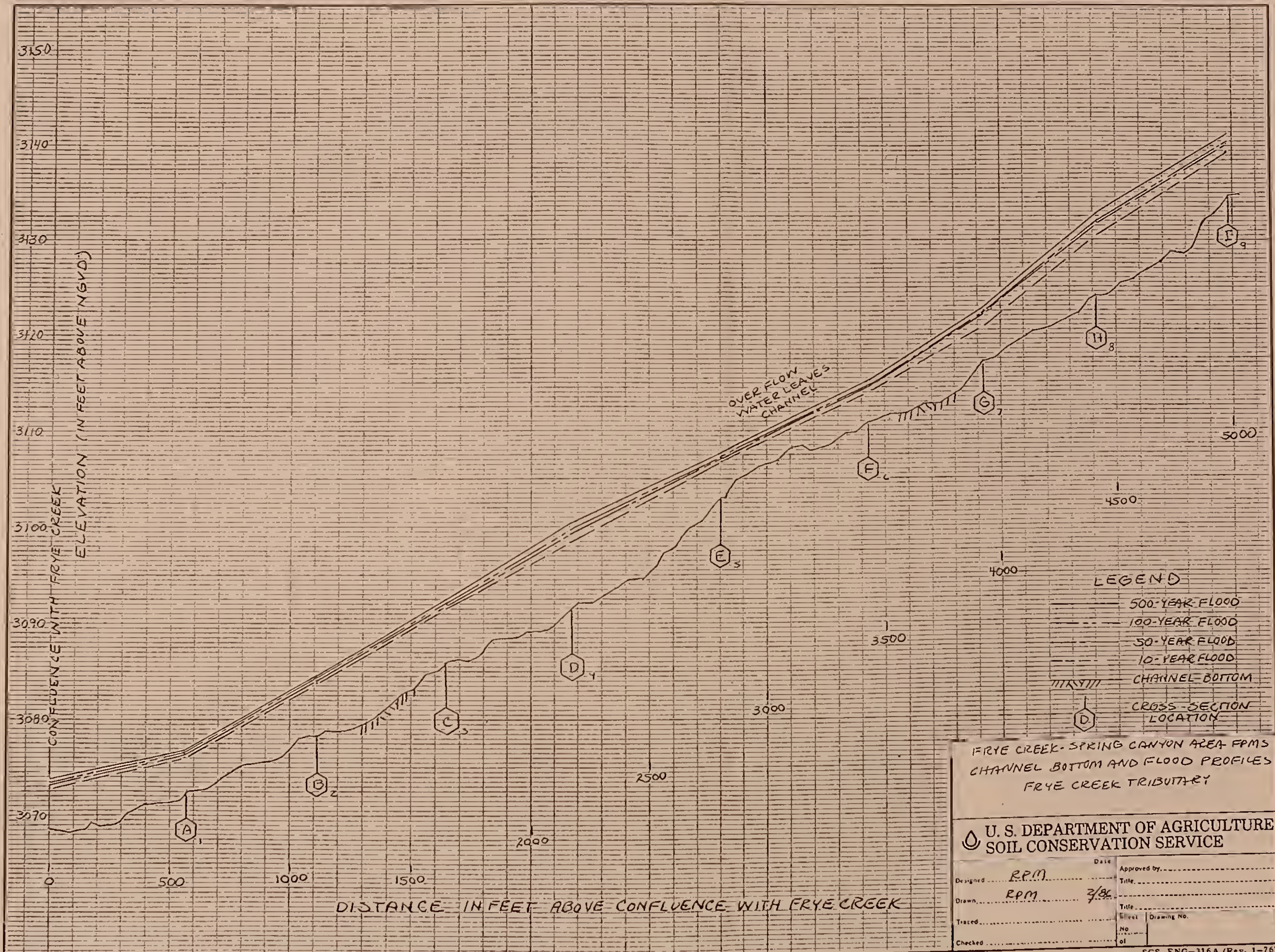
3150
3140
3130
3120
3110
3100
3090
3080
3070
CONFLUENCE WITH FRYE CREEK
ELEVATION (IN FEET ABOVE NGVD)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
DISTANCE IN FEET ABOVE CONFLUENCE WITH FRYE CREEK
OVER FLOW WATER LEAVES CHANNEL
A 1
B 2
C 3
D 4
E 5
F 6
G 7
H 8
I 9
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
FRYE CREEK-SPRING CANYON AREA FPMS
CHANNEL BOTTOM AND FLOOD PROFILES
FRYE CREEK TRIBUTARY
U. S. DEPARTMENT OF AGRICULTURE
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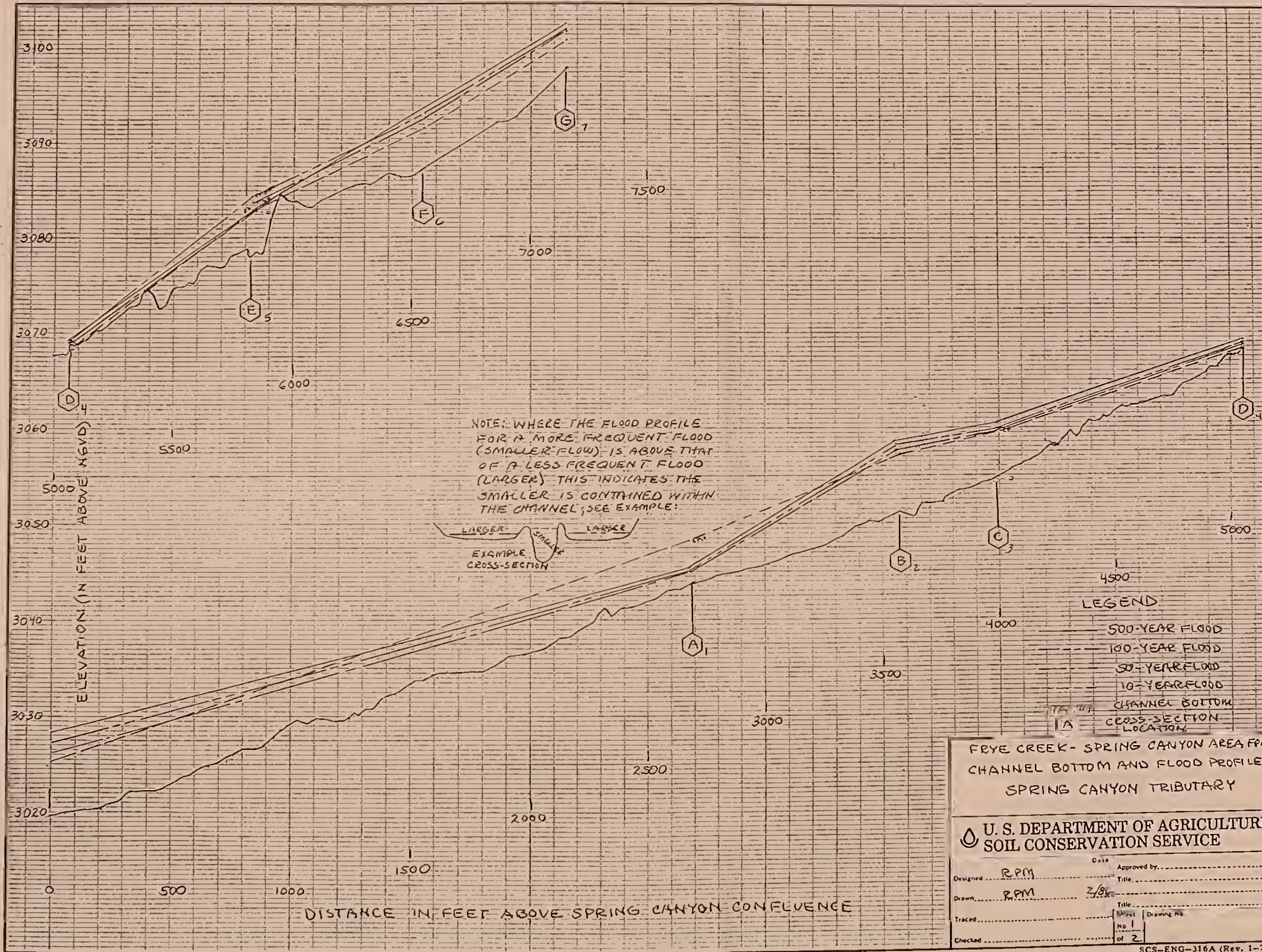
3100
3090
3080
3070
3060
3050
3040
3030
3020
ELEVATION (IN FEET ABOVE NGVD)
DISTANCE IN FEET ABOVE SPRING CANYON CONFLUENCE
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
A 1
B 2
C 3
D 4
E 5
F 6
G 7
NOTE: WHERE THE FLOOD PROFILE FOR A MORE FREQUENT FLOOD (SMALLER FLOW) IS ABOVE THAT OF A LESS FREQUENT FLOOD (LARGER) THIS INDICATES THE SMALLER IS CONTAINED WITHIN THE CHANNEL; SEE EXAMPLE:
LARGER
SMALLER
LARGER
EXAMPLE CROSS-SECTION
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
A CROSS-SECTION LOCATION
FRYE CREEK - SPRING CANYON AREA FPAC
CHANNEL BOTTOM AND FLOOD PROFILES
SPRING CANYON TRIBUTARY
U. S. DEPARTMENT OF AGRICULTURE
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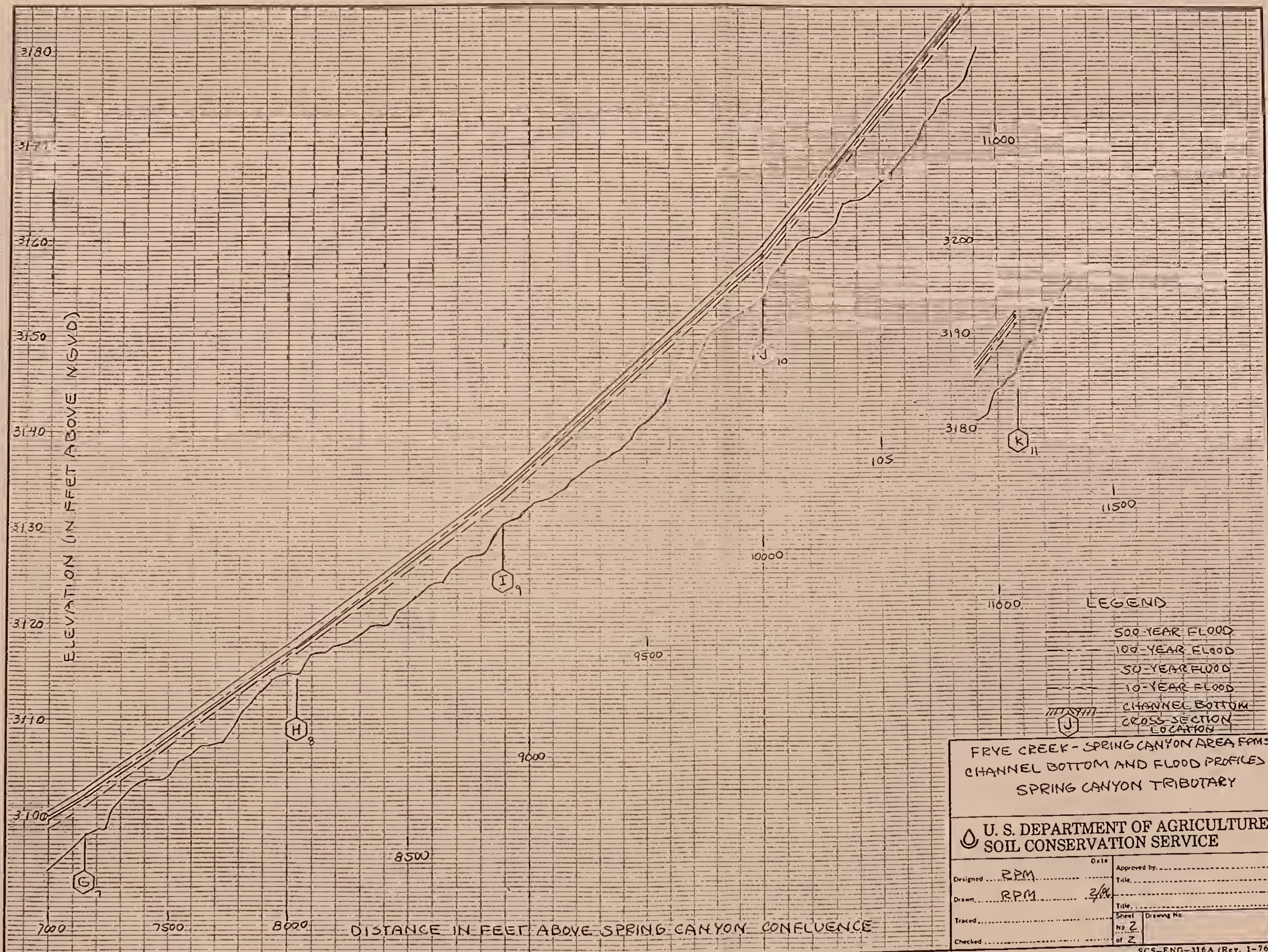
ELEVATION (IN FEET ABOVE N.G.V.D.)
3180
3170
3160
3150
3140
3130
3120
3110
3100
3200
3190
3180
DISTANCE IN FEET ABOVE SPRING CANYON CONFLUENCE
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
11000
G
7
H
8
I
9
J
10
K
11
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS SECTION LOCATION
J
FRYE CREEK - SPRING CANYON AREA FPMS
CHANNEL BOTTOM AND FLOOD PROFILES
SPRING CANYON TRIBUTARY
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed RPM
Drawn RPM 2/84
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Date
Approved by
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Sheet No. 2 of 2
Drawing No.
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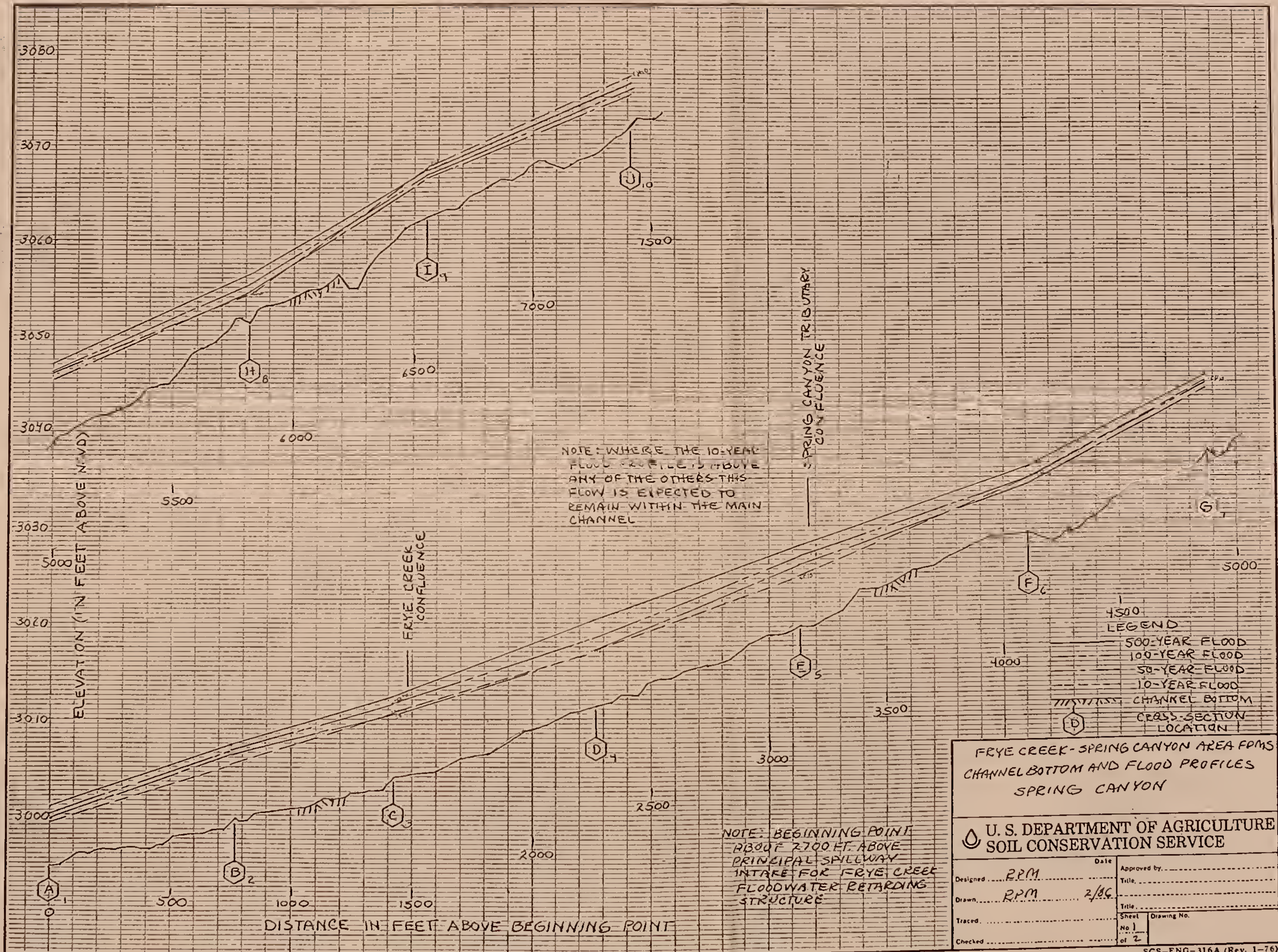
ELEVATION (IN FEET ABOVE NGVD)
DISTANCE IN FEET ABOVE BEGINNING POINT
SPRING CANYON TRIBUTARY CONFLUENCE
FRYE CREEK CONFLUENCE
NOTE: WHERE THE 10-YEAR FLOOD PROFILE IS ABOVE ANY OF THE OTHERS THIS FLOW IS EXPECTED TO REMAIN WITHIN THE MAIN CHANNEL
NOTE: BEGINNING POINT ABOUT 2700 FT. ABOVE PRINCIPAL SPILLWAY INTAKE FOR FRYE CREEK FLOODWATER RETARDING STRUCTURE
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
FRYE CREEK - SPRING CANYON AREA FPMS
CHANNEL BOTTOM AND FLOOD PROFILES
SPRING CANYON
U. S. DEPARTMENT OF AGRICULTURE
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Designed RPM
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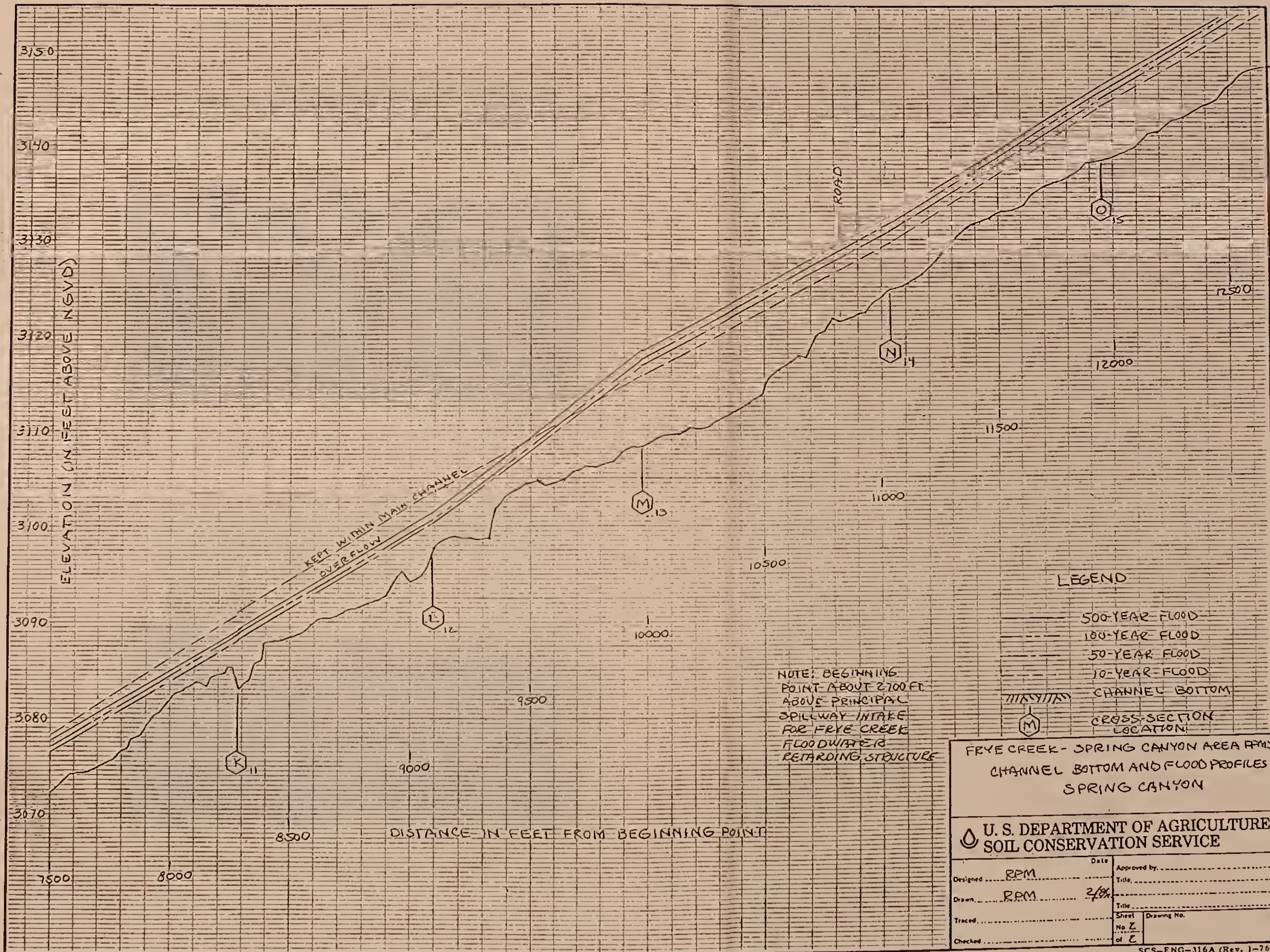

ELEVATION (IN FEET ABOVE NGVD)
3150
3140
3130
3120
3110
3100
3090
3080
3070
ROAD
KEPT WITHIN MAIN CHANNEL
OVERFLOW
7500
8000
8500
9000
9500
10000
10500
11000
11500
12000
12500
DISTANCE IN FEET FROM BEGINNING POINT
NOTE: BEGINNING POINT ABOUT 2700 FT. ABOVE PRINCIPAL SPILLWAY INTAKE FOR FRYE CREEK FLOODWATER RETARDING STRUCTURE
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
CHANNEL BOTTOM
CROSS-SECTION LOCATION
FRYE CREEK - SPRING CANYON AREA RPMS
CHANNEL BOTTOM AND FLOOD PROFILES
SPRING CANYON
U. S. DEPARTMENT OF AGRICULTURE
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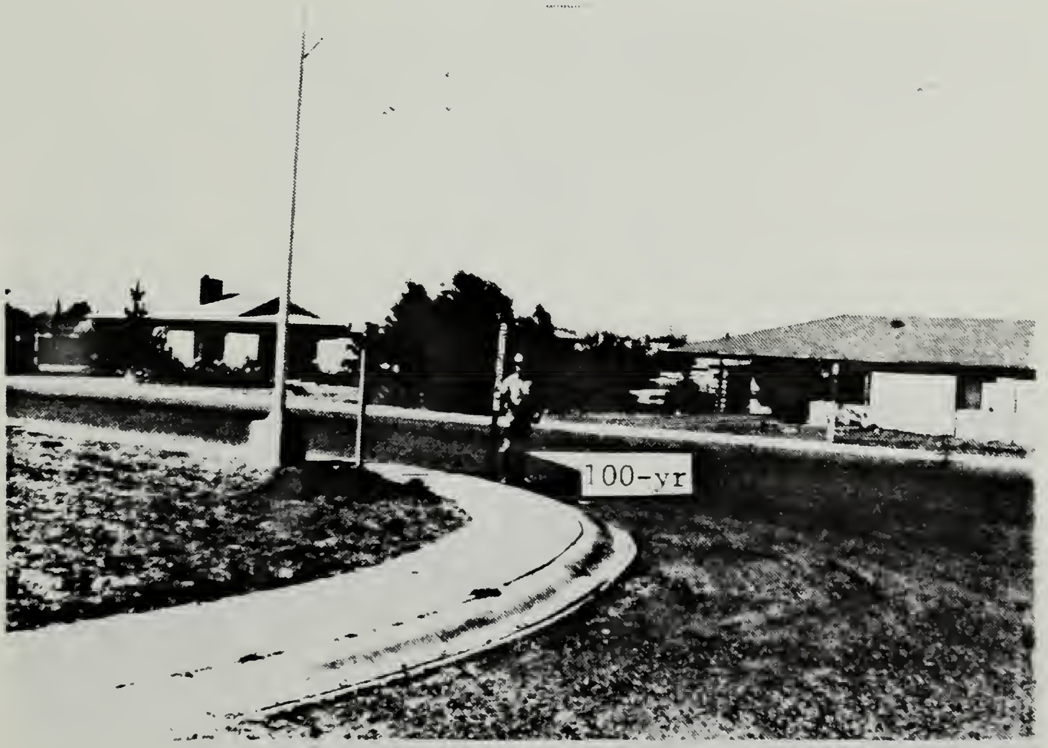
FRYE CREEK at Frye Creek Road; looking north, with Safford Municipal Golf Course in background. Depth, 5 ft.

Looking north at Fairway Avenue at intersection of Brinkerhoff Street and Fairway Avenue. Depth, 1.3. ft.

Intersection of Pace Street and Fairway Avenue;
Fairway Avenue in left foreground. Depth, 1.9 ft.

Intersection of Golf Course Street and Fairway
Avenue; Fairway Avenue on left of photo. Depth, 2.0 ft.

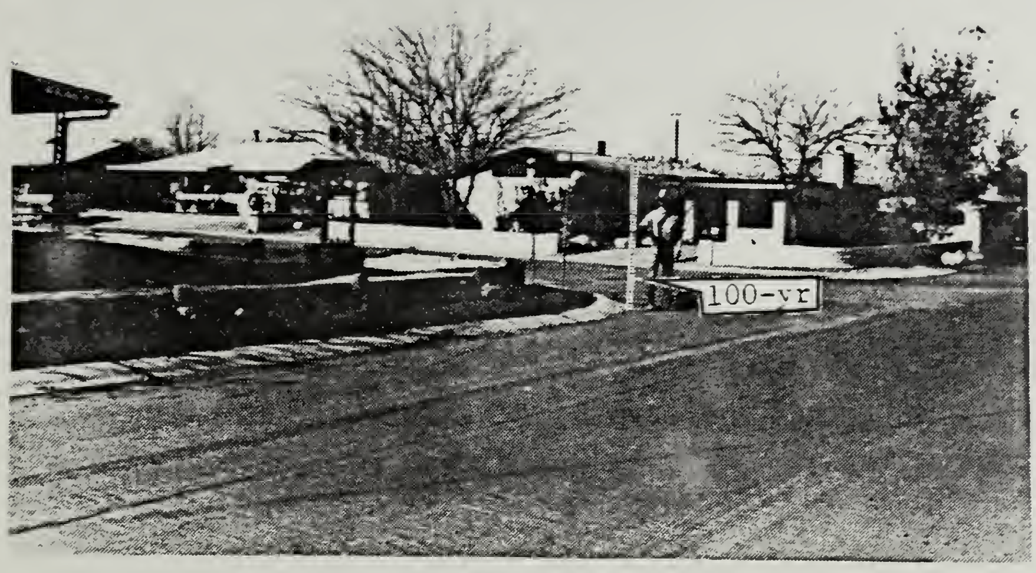
Intersection of Bingham Street and
Fairway Avenue. Depth, 2.2 ft.



Intersection of Kimball Street and Robinson Avenue.
Depth, 1.5 ft.

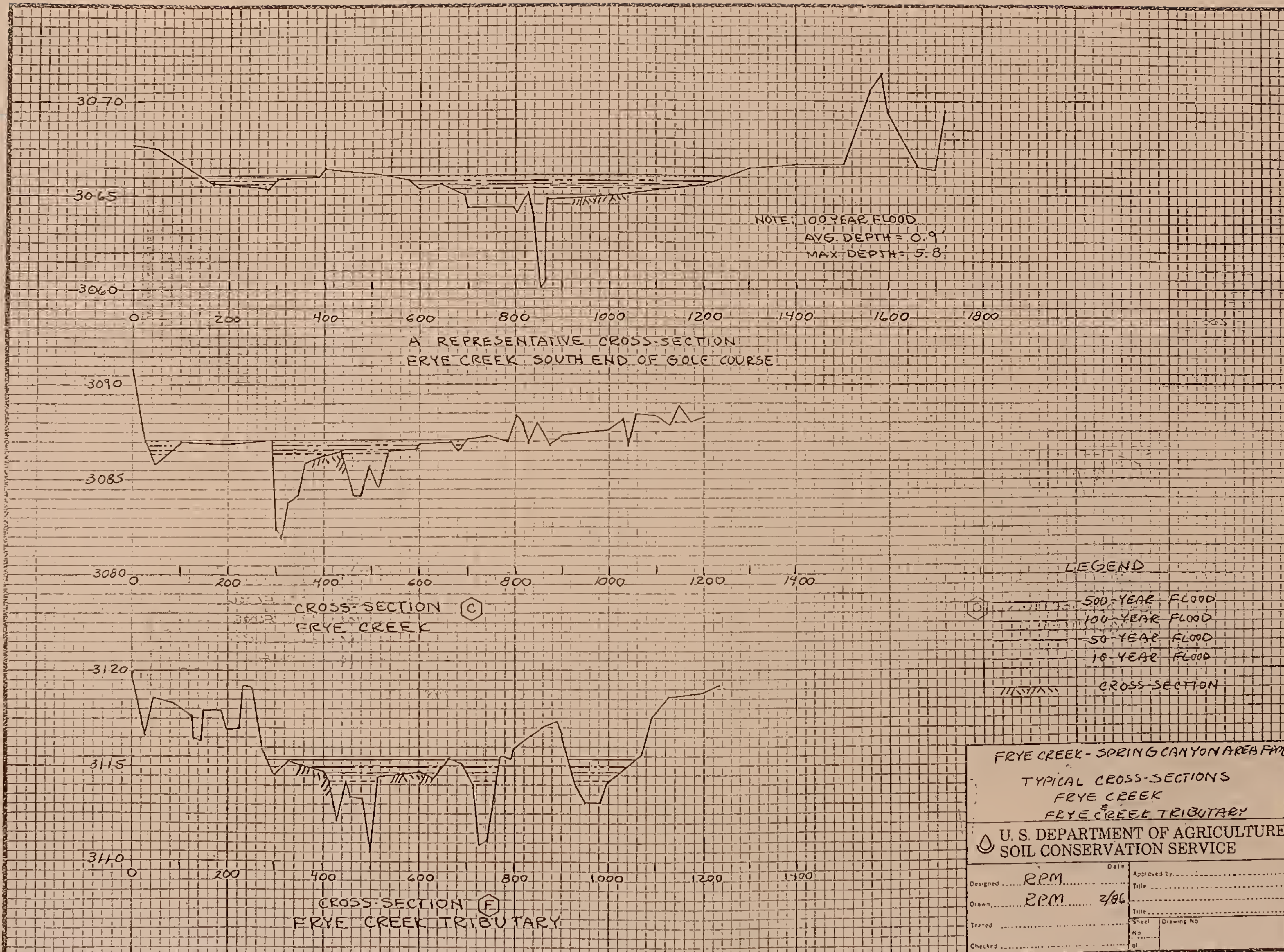
Intersection of Fuller Street and Hoopes Avenue,
Hoopes Avenue on right of photo. Depth, 1.0 ft.

Intersection of Brinkerhoff Street and
Hoopes Avenue; looking north-northwest
with Hoopes Avenue on right. Depth, 1.5 ft.

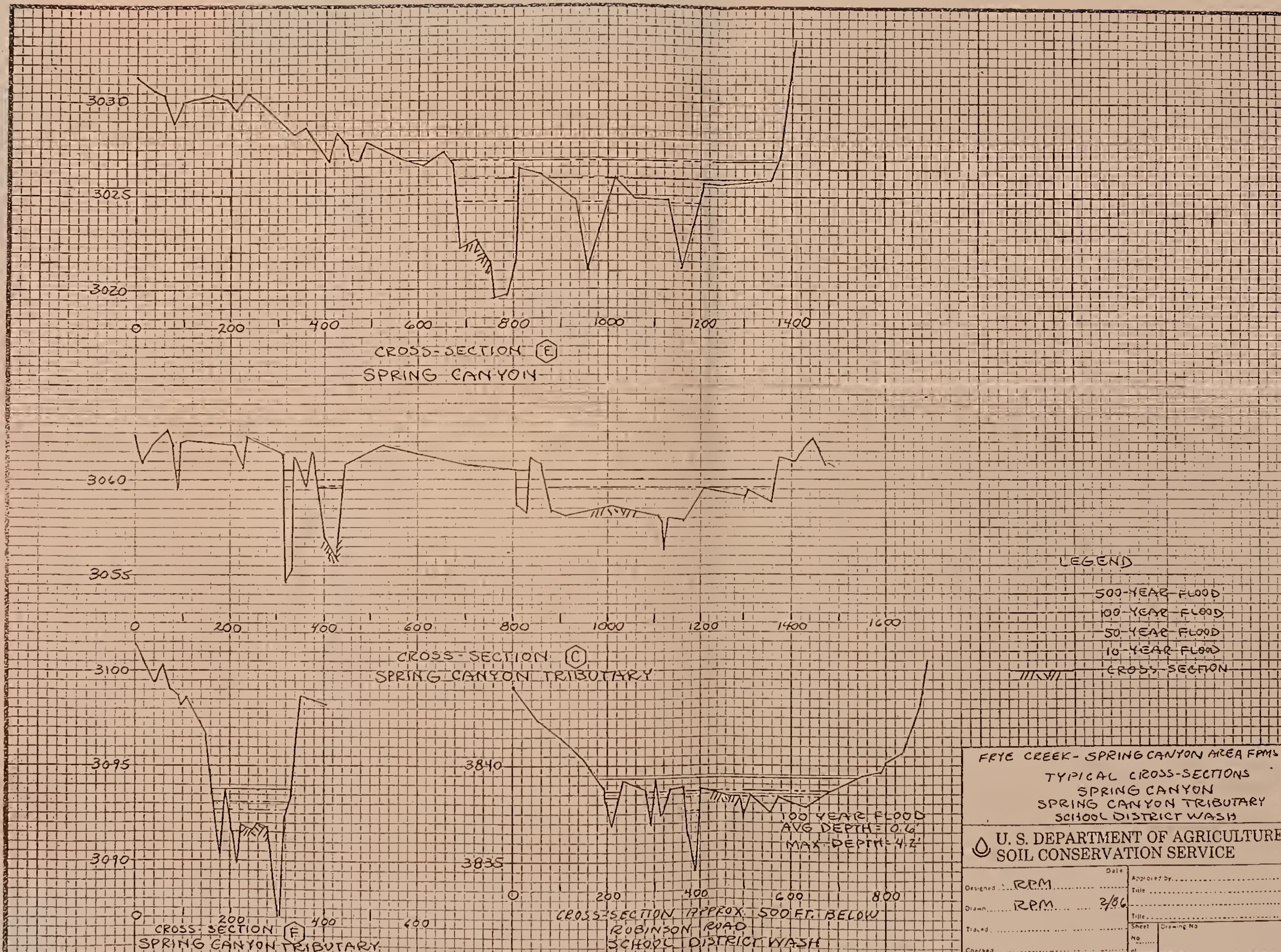


Intersection of Claridge Street and Hoopes Avenue; Hoopes Avenue in foreground. Depth, 1.7 ft.

Intersection of Golf Course Street and Hoopes Avenue. Looking north-northwest. Depth, 1.8 ft.



SCS-ENG-315A (3-81)



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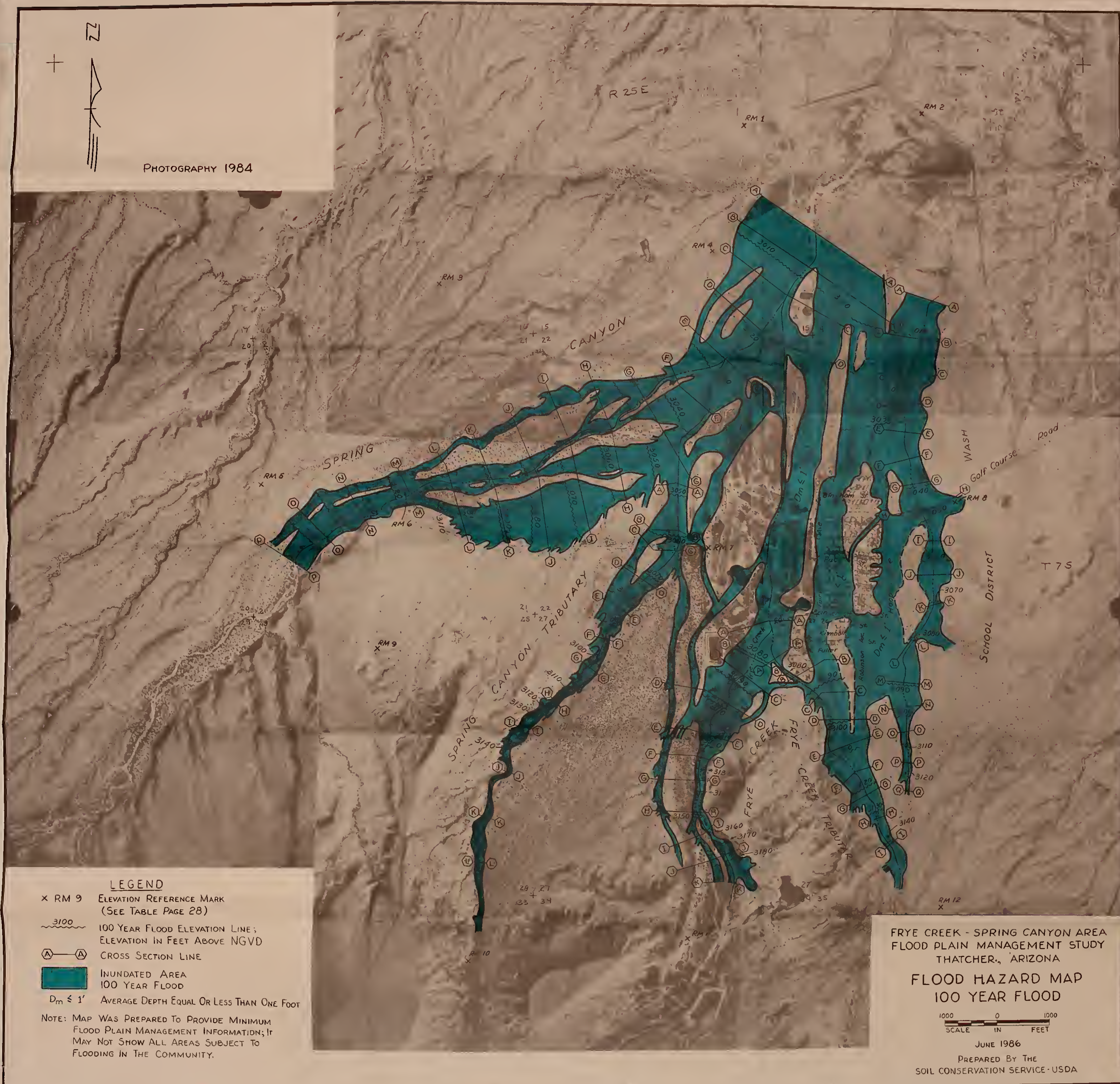


Legend

× RM 9 Elevation Reference Mark (See Table Page 28)

3100 — 100 Year Flood Elevation Line; Elevation In Feet Above NGVD

Ⓐ—Ⓐ Cross Section Line

Inundated Area 100 Year Flood

$D_m \leq 1'$ Average Depth Equal Or Less Than One Foot

Note: Map Was Prepared To Provide Minimum Flood Plain Management Information; It May Not Show All Areas Subject To Flooding In The Community.

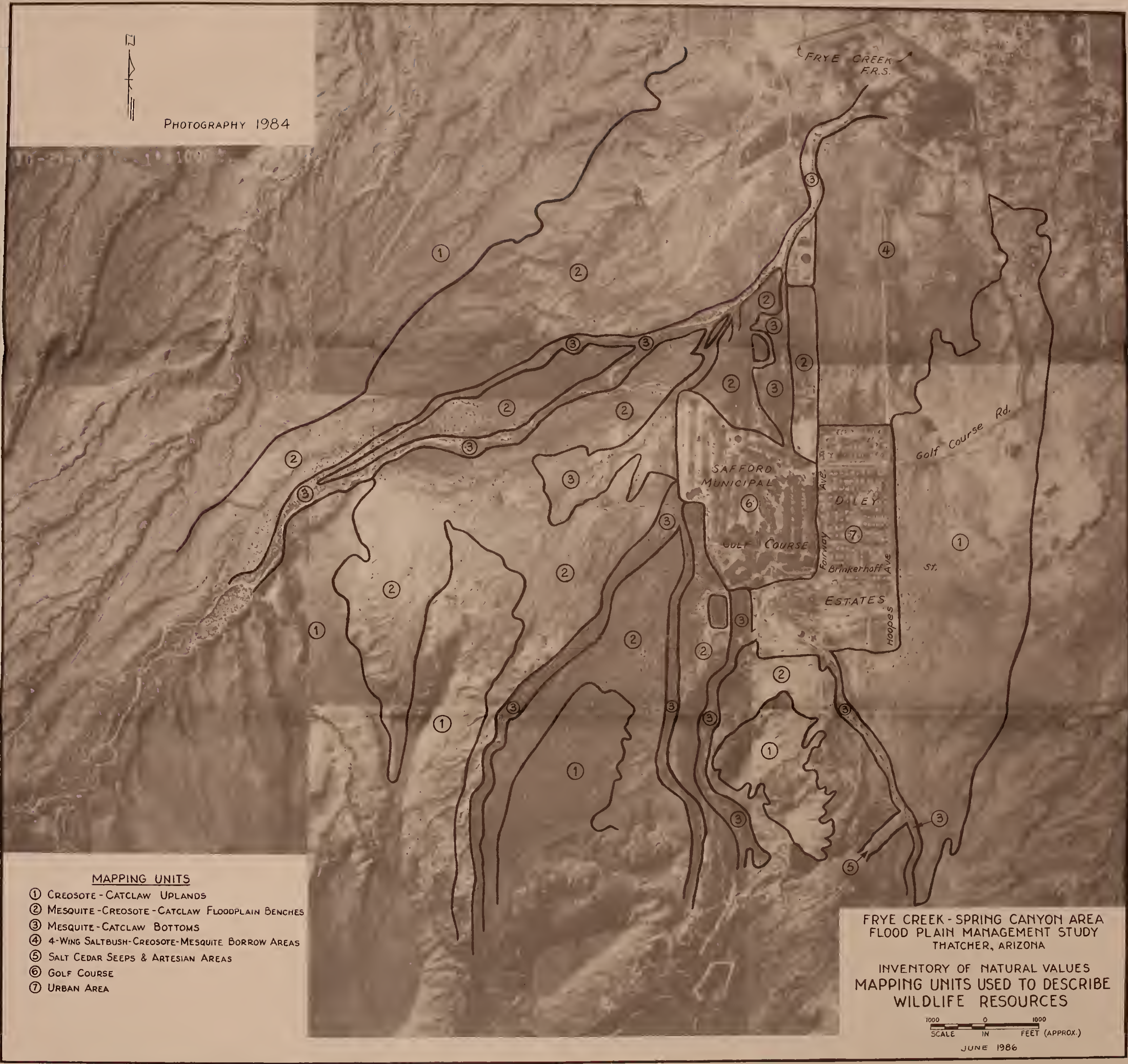
Frye Creek - Spring Canyon Area
Flood Plain Management Study
Thatcher, Arizona

Flood Hazard Map
100 Year Flood

1000 0 1000
Scale In Feet

June 1986

Prepared By The
Soil Conservation Service - USDA


PHOTOGRAPHY 1984
FRYE CREEK F.R.S.
SAFFORD MUNICIPAL GOLF COURSE
DALEY ESTATES
Fairway Ave.
Brinkerhoff Ave.
Hoopes
St.
Golf Course Rd.
MAPPING UNITS
① CREOSOTE - CATCLAW UPLANDS
② MESQUITE - CREOSOTE - CATCLAW FLOODPLAIN BENCHES
③ MESQUITE - CATCLAW BOTTOMS
④ 4-WING SALTBUSH - CREOSOTE - MESQUITE BORROW AREAS
⑤ SALT CEDAR SEEPS & ARTESIAN AREAS
⑥ GOLF COURSE
⑦ URBAN AREA
FRYE CREEK - SPRING CANYON AREA
FLOOD PLAIN MANAGEMENT STUDY
THATCHER, ARIZONA
INVENTORY OF NATURAL VALUES
MAPPING UNITS USED TO DESCRIBE WILDLIFE RESOURCES
1000 0 1000
SCALE IN FEET (APPROX.)
JUNE 1986